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PART V

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# TRAWL FISHERIES AND HERRING GILLNET FISHERY OF EASTERN BERING SEA AND NORTHEAST PACIFIC

## Preliminary Fishery Management Plan

## DEPARTMENT OF COMMERCE

### National Oceanic and Atmospheric Administration

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### Preliminary Fishery Management Plan

On the 4th of February, 1977, the Secretary of Commerce, through an appropriate delegation of authority to the Associate Administrator for Marine Resources of the National Oceanic and Atmospheric Administration and the Director of the National Marine Fisheries Service, published a Notice of Determination, Preparation, Issuance, and Implementation of Preliminary Fishery Management Plans at 42 FR 6873. In order that each Plan may have the widest possible circulation, the Secretary has decided that each should be published in the FEDERAL REGISTER.

Dated the 4th day of February, 1977 at Washington, D.C.

WINFRED H. MEIBORN,
*Associate Director, National Marine Fisheries Service.*

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### 1.0 INTRODUCTION

Resumption by Japan in 1954 of the limited trawling it had carried out prior to World War II marked the birth of the contemporary international fishery for bottomfish and herring in the Bering Sea-Aleutian Island region. Prior fishing was on a small scale—by Alaska natives for subsistence, by U.S. commercial fishermen for Pacific cod, and by U.S. and Canadian commercial fishermen for Pacific halibut. Since 1954 the fishery has expanded greatly in size of harvests and area of operations until it now ranks among the major fisheries in the world. The fishery has impacted both directly and indirectly on U.S. fisheries. This preliminary management plan is in direct response to the legislative requirements mandated by Pub. L. 94–265.

### 2.0 DESCRIPTION OF THE FISHERY

#### A. AREA STOCKS INVOLVED

The Bering Sea is characterized by an extensive area of continental shelf (approximately 1,000,000 km$^2$) and other features which favor the development of large bottomfish resources. Comprehensive resource surveys by the Soviet Union (Moiseev, 1964), the history of commercial fisheries (Pruter, 1973), and resource surveys by the National Marine Fisheries Service have shown the Bering Sea to be among the most productive fishing areas in the world. Over 300 fish species are known to occur in the Bering Sea (Wilimovsky, 1974), of which less than 15 species (excluding Salmon, shrimp, and crab) have been the target of the combined fisheries of Japan, the Republic of Korea, the Soviet Union, and the United States. In terms of commercial production, however, the annual total catch by all nations from the eastern Bering Sea approached or considerably exceeded 2 million mt during the 5 years 1969–1973, representing 76 to 86 percent of the groundfish and herring catch for the entire region from the Bering Sea to California.

There are important differences between the bottomfish community within the Bering Sea and those to the east and south in the Gulf of Alaska and Washington-California areas. In terms of biomass, the bottomfish community within the Bering Sea is much larger than its counterparts in the other areas. Since there also is a general simplification in the diversity of bottomfish species within the Bering Sea, the result is that certain species inhabiting the Bering Sea comprise some of the largest bottomfish resources found anywhere in the world.

Although in terms of biomass Alaska pollock dominates the community of demersal roundfishes within the eastern Bering Sea, there also are several other roundfishes which form large commercial aggregations. They include Pacific cod (*Gadus macrocephalus*); Pacific ocean perch (*Sebastes alutus*); sablefish, or blackcod (*Anoplopoma fimbria*); and grenadiers, or rattails (*Corphaenoides* sp.). Pacific cod mostly occurs on the continental shelf and often in close association with walleye, or Alaska, pollock (*Theragra chalcogramma*). The Bering Sea is characterized by a great reduction in number of rockfish species, compared to regions to the east and south, and a virtual absence of shallow-water forms. The three other rockfishes besides Pacific ocean perch which are fairly abundant in the eastern Bering Sea are *Sebastes aleutianus* and *Sebastes mystinus* and members of the genus *Sebastolobus*. All are residents of relatively deep waters of the outer shelf and upper continental slope. Sablefish and grenadiers are among the deepest-dwelling of the bottomfishes with commercial quantities occurring to depths of perhaps over 1,000 meters. Sablefish migrate rather freely between the deep waters of the slope and the shallower waters of the shelf; however, grenadiers are permanent residents of the deep, slope waters.

Whereas comparatively few species of commercially exploited roundfishes inhabit the eastern Bering Sea, there is no similar reduction in diversity of the flatfish community compared to the other areas to the east and south. Among the species which are known to occur in commercial aggregations are yellowfin sole (*Limanda aspera*), rock sole (*Lepidopsetta bilineata*), starry flounder (*Platichthys stellatus*), Alaska plaice (*Pleuronectes quadrituberculatus*), flathead sole (*Hippoglossoides elassodon*), Pacific halibut (*Hippoglossus stenolepis*), Greenland turbot (*Reinhardtius hippoglossoides*), and arrowtooth flounder (*Atheresthes stomias*). Starry flounder is confined to coastal waters including those around the mouths of rivers. Yellowfin sole, rock sole, and Alaska plaice mostly occur on the Continental Shelf and, in summer particularly, on the inner shelf. Flathead sole, Pacific halibut, Greenland turbot, and arrowtooth flounder can be found in both shelf and slope waters with Pacific halibut occupying the greatest bathymetric range of all—from shallow bays to slope waters of over 500 meters in depth.

Elasmobranchs are relatively scarce in the eastern Bering Sea. Only skates (Rajidae) occur in significant quantities, but less so than in waters to the east and south.

In winter most of the bottomfishes retreat to waters overlying the outer shelf or upper slope in order to avoid below zero temperatures associated with the ice which at that time of year covers most

of the Bering Sea. The onset of spring brings warmer temperatures, a northward recession of ice, and the movement of many species out of the deep and onto the shelf to commence feeding migrations. Hydrographical conditions, even in summer, are conducive to formation of surface lenses of cold water (so-called "cold spots") whose location varies from year to year and even season to season. Knowledge of the location of these cold spots and being able to predict their effects on fishes are of great practical importance to the fishing fleets.

Although the picture is not clear, evidence suggests that most of the bottomfish in the eastern Bering Sea can be viewed as being permanent residents of that area. Some exchange with grounds off Siberia, the Gulf of Alaska, and as far south as off California has been noted for Pacific halibut and sablefish. The significance of these movements cannot yet be quantified, but it appears that the displacement of Pacific halibut and sablefish populations by emigration and immigration is a slow process. An aspect which could void the usefulness of this approach is the unknown extent to which the eastern Bering Sea may serve as a nursery ground for other regions. Large numbers of juvenile halibut are found in the southeastern Bering Sea but how important they are for replenishment of populations elsewhere is not clear. Little is known about the importance of the Bering Sea as a spawning and nursery area for sablefish, let alone whether juveniles from there contribute as recruits to populations outside the Bering Sea.

B. HISTORY OF EXPLOITATION

Sea mammals—not fish—were the incentive for the initial exploitation of Bering Sea resources in the 18th and 19th centuries. Some knowledge of fish and shellfish resources was obtained incidental to the early hunting of sea otters, fur seals, and whales, but the first commercial venture for bottomfish did not occur until 1864 when U.S. schooners began fishing for cod (Cobb, 1927). The fishery was carried out from ports in Washington and California as well as from shore stations in Alaska. Landings of cod were largest during World War I when almost 4 million fish were taken annually. Demand for cod declined in subsequent years and the U.S. line fishery was discontinued by the mid-1950's (Alverson et al., 1964). Most of the U.S. line catch of cod probably was from the Bering Sea and Aleutian Islands with the remainder from the Gulf of Alaska. Canadian vessels participated to a very limited extent in the line fishery for cod. It is not clear whether such participation occurred prior to 1900, but it is known that one or two Canadian operations for cod were carried out off Alaska about 1903 and 1913 (Forrester et al., in press).

Halibut were reported as being present in the Bering Sea by United States cod vessels as early as the 1880's. However, halibut did not reach North American markets from the Bering Sea until 1928 (Thompson and Freeman, 1930). Small and infrequent landings of halibut were made by United States and Canadian vessels between 1928 and 1950; catches were not landed every year until 1952 (Dunlop et al., 1964).

Present participation by North American nationals in the fisheries for bottomfish is confined to a relatively small longline fishery for halibut by United States and Canadian fishermen in the eastern Bering Sea and around the Aleutian Islands. There is also a small subsistence fishery for Pacific herring (*Clupea harengus pallasi*) by Alaskan natives at scattered places along the coast.

The earliest reported fishing by Japanese vessels off Alaska resulted from an order issued by the Secretary of Commerce in April 1918 and terminated in July 1921, which suspended the law forbidding the landing of catches by foreign vessels in U.S. ports. The suspension was to encourage the importation of fish in order to compensate for reduced food supplies caused by World War I. During the time the suspension was in effect, Japanese vessels landed 4½ million dry-salted cod and 176,000 pounds of stockfish at San Francisco and Puget Sound ports (Cobb, 1927). Although most of this cod was from around the Kurile Islands and Okhotsk Sea, in a few instances the Japanese vessels caught their fish off Alaska. Information is not available on whether the cod caught by Japanese vessels off Alaska were from the Bering Sea-Aleutian Island area or from the Gulf of Alaska.

The next effort by Japan off Alaska was a trawl fishery. Japanese exploratory trawlers carried out limited surveys of bottomfish resources in the Bering Sea as early as 1929–1931, and the first commercial operations were in 1933–1937 (Bourgois, 1951). This initial trawling venture by Japan was for fish meal and oil. It was followed by trawling in 1940–1941 for frozen fish for use as human food. Both the fish meal and frozen fish operations were off Alaska in Bristol Bay. The pre-World War II production of bottomfish by Japan from the Bering Sea is estimated to have amounted to less than 150,000 mt and was mostly comprised of flatfishes and walleye pollock.

Japan resumed its fishing operations in the eastern Bering Sea in 1954 and by 1961 the catch of bottomfish and herring had grown to over 600,000 mt. Catches declined to around 300,000 tons in 1963 but thereafter increased to about 1¾ million tons in 1971. The decline in catches between 1961 and 1963 was caused by overfishing of yellowfin sole by the combined efforts of Japan and the U.S.S.R.; the great increase in harvest after 1963 resulted from a shift to walleye pollock as Japan's primary target species. Catches of bottomfish and herring by Japan from the Bering Sea averaged 1.7 million mt annually during the period 1970–1974 and over 80 percent was comprised of walleye pollock.

The U.S.S.R. was the next nation to send its vessels to fishing grounds in the eastern Bering Sea. In 1959, the U.S.S.R. initiated winter fisheries for flatfishes and herring off Alaska in the southeastern Bering Sea (Chitwood, 1969). Both fisheries were at least in partial response to declining catches of flatfishes and herring in the Soviet Far East. Declining yields of yellowfin sole after the early 1960's and a sharp drop in production of herring after 1964 caused the Soviets to increasingly seek other species in the eastern Bering Sea. Alternate target species at first were rockfishes, primarily Pacific ocean perch, sablefish, and other species of flatfishes besides yellowfin sole. A significant recent event has been the entry of the U.S.S.R. into the fishery for walleye pollock which, since its inception, had been dominated by Japan. The first catch of pollock reported by the U.S.S.R. from the eastern Bering Sea was in 1969 when 27,000 mt were harvested. The Soviet fishery for pollock thereafter assumed increasing importance, exceeding 300,000 mt in 1974. Annual catches of bottomfish and herring from the Bering Sea by Soviet vessels averaged 0.4 million mt during the period 1970–1974.

In 1967 a trawler from South Korea commenced operations in the eastern Bering Sea. This scouting effort was followed in subsequent years by trawling for walleye pollock and other species of bottomfish and longlining for sablefish. Because South Korea has not provided statistics on its catches, it has been necessary to estimate harvests from observations by NMFS Law Enforcement personnel. According to these estimates, vessels of South Korea caught an annual average of 12,000 mt of bottomfish in the eastern Bering Sea during the period 1970–1974.

Participation has been minimal by other nations in the Bering Sea fisheries for bottomfish and herring. Polish vessels are believed to have caught about 400 mt of bottomfish in the eastern Bering Sea in 1973 and one trawler from Taiwan made three trips there between December 1974 and May 1975 with a reported catch target of 2,250 mt. Taiwan reportedly has few trawlers in its fleet which are large enough or suitably equipped for fishing in the eastern Bering Sea. However, there are many vessels among Taiwan's fleet of several hundred tuna longliners which could be converted to longlining for sablefish or other species.

Catches by each nation participating in the Bering Sea fisheries for bottomfish and herring are shown in Table 1 for the period 1933–1974. During this period, fishing by the United States was confined to comparatively small longline efforts for Pacific halibut and Pacific cod in addition to a subsistence fishery by Alaskan natives for herring. From the standpoint of size of harvests, the fishery has been dominated by Japan, whose cumulative catches of bottomfish and herring during the period 1933–1974 amounted to 14.9 million mt, or 77.8 percent of the all-nation harvest. The U.S.S.R. accounted for most of the remaining harvest—4.2 million mt or 21.7 percent of the cumulative total.

C. THE CONTEMPORARY FISHERY

(1) *United States and Canada.*—The contemporary United States fishery for bottomfish differs from those of other nations not only from the standpoint of the much smaller harvests taken, but also in the basic character of the fishing operation itself. The United States (and Canadian) fishery is directed entirely toward Pacific halibut and is prosecuted by small longline vessels. These longliners deliver their catches (Table 1) to ports in Alaska, Washington, and Canada when they are processed ashore. In contrast, other nations carry out distant-water operations in which fleets of large catcher vessels seek a variety of species and the catches are either processed at sea aboard the catcher vessels themselves or are transferred to factoryships, also called motherships, for processing. The foreign, distant-water fleets typically include a variety of support vessels besides factoryships, including refrigerator transports, oil tankers, personnel transports, hospital ships, tugs, patrol vessels, and research vessels. The flotillas of Japanese and Soviet vessels are self-supporting and usually obtain all their supplies and services from the homeland, except sometimes to obtain emergency medical aid in the United States for seriously injured or sick crewmen.

TABLE 1.—*Catches of bottomfish and herring in thousands of metric tons by all nations from the Bering Sea and Aleutian Island regions in calendar years 1933–74. Catches shown for the United States are Pacific halibut. Not included for the United States are catches of herring by Alaska Natives for subsistence purposes and line catches of Pacific cod curing the period 1882–1955 which were mostly delivered to Washington and California ports*

| Year and fishery | United States | Canada | Japan | U.S.S.R. | South Korea | Poland | Taiwan | Total |
|---|---|---|---|---|---|---|---|---|
| 1933: | | | | | | | | |
| Bottomfish | | | 3 | | | | | 3 |
| Herring | (?) | | | | | | | |
| Total | | | 3 | | | | | 3 |
| 1934: | | | | | | | | |
| Bottomfish | | | 15 | | | | | 15 |
| Herring | (?) | | | | | | | |
| Total | | | 15 | | | | | 15 |
| 1935: | | | | | | | | |
| Bottomfish | | | 29 | | | | | 29 |
| Herring | (?) | | | | | | | |
| Total | | | 29 | | | | | 29 |
| 1936: | | | | | | | | |
| Bottomfish | | | 27 | | | | | 27 |
| Herring | (?) | | | | | | | |
| Total | | | 27 | | | | | 27 |
| 1937: | | | | | | | | |
| Bottomfish | | | 43 | | | | | 43 |
| Herring | (?) | | | | | | | |
| Total | | | 43 | | | | | 43 |
| 1940: | | | | | | | | |
| Bottomfish | | | 10 | | | | | 10 |
| Herring | (?) | | | | | | | |
| Total | | | 10 | | | | | 10 |
| 1941: | | | | | | | | |
| Bottomfish | | | 12 | | | | | 12 |
| Herring | (?) | | | | | | | |
| Total | | | 12 | | | | | 12 |
| 1945: | | | | | | | | |
| Bottomfish | Tr. | | | | | | | Tr. |
| Herring | (?) | | | | | | | |
| Total | Tr. | | | | | | | Tr. |
| 1950: | | | | | | | | |
| Bottomfish | Tr. | | | | | | | Tr. |
| Herring | (?) | | | | | | | |
| Total | Tr. | | | | | | | Tr. |
| 1952: | | | | | | | | |
| Bottomfish | Tr. | | | | | | | Tr. |
| Herring | (?) | | | | | | | |
| Total | Tr. | | | | | | | Tr. |
| 1953: | | | | | | | | |
| Bottomfish | Tr. | | | | | | | Tr. |
| Herring | (?) | | | | | | | |
| Total | Tr. | | | | | | | |
| Total | Tr. | | | | | | | |
| 1954: | | | | | | | | |
| Bottomfish | Tr. | | | 12 | | | | 12 |
| Herring | (?) | | | | | | | |
| Total | Tr. | | | 12 | | | | 12 |
| 1955: | | | | | | | | |
| Bottomfish | Tr. | | | 15 | | | | 15 |
| Herring | (?) | | | | | | | |
| Total | Tr. | | | 15 | | | | 15 |
| 1960: | | | | | | | | |
| Bottomfish | Tr. | Tr. | | 25 | | | | 25 |
| Herring | (?) | | | | | | | |
| Total | Tr. | Tr. | | 25 | | | | 25 |

| Year and fishery | United States | Canada | Japan | U.S.S.R. | South Korea | Poland | Taiwan | Total |
|---|---|---|---|---|---|---|---|---|
| 1957: | | | | | | | | |
| Bottomfish | Tr. | | 24 | | | | | 24 |
| Herring | (?) | | | | | | | |
| Total | Tr. | | 24 | | | | | 24 |
| 1958: | | | | | | | | |
| Bottomfish | Tr. | 1 | 48 | | | | | 49 |
| Herring | (?) | | | | | | | |
| Total | Tr. | 1 | 48 | | | | | 49 |
| 1959: | | | | | | | | |
| Bottomfish | 1 | 1 | 162 | 75 | | | | 239 |
| Herring | (?) | | | 10 | | | | 10 |
| Total | 1 | 1 | 162 | 85 | | | | 249 |
| 1960: | | | | | | | | |
| Bottomfish | 1 | 2 | 449 | 95 | | | | 547 |
| Herring | (?) | | | 10 | | | | 10 |
| Total | 1 | 2 | 449 | 105 | | | | 557 |
| 1961: | | | | | | | | |
| Bottomfish | 1 | 1 | 540 | 100 | | | | 642 |
| Herring | (?) | | 74 | 80 | | | | 154 |
| Total | 1 | 1 | 614 | 180 | | | | 796 |
| 1962: | | | | | | | | |
| Bottomfish | 2 | 2 | 479 | 95 | | | | 578 |
| Herring | (?) | | 10 | 150 | | | | 160 |
| Total | 2 | 2 | 489 | 245 | | | | 738 |
| 1963: | | | | | | | | |
| Bottomfish | 2 | 2 | 238 | 102 | | | | 344 |
| Herring | (?) | | 32 | 150 | | | | 182 |
| Total | 2 | 2 | 270 | 252 | | | | 526 |
| 1964: | | | | | | | | |
| Bottomfish | 1 | 1 | 357 | 122 | | | | 481 |
| Herring | (?) | | 43 | 176 | | | | 219 |
| Total | 1 | 1 | 400 | 298 | | | | 700 |
| 1965: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 353 | 170 | | | | 523 |
| Herring | (?) | | 36 | 10 | | | | 46 |
| Total | Tr. | Tr. | 389 | 180 | | | | 569 |
| 1966: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 420 | 130 | | | | 550 |
| Herring | (?) | | 28 | 5 | | | | 33 |
| Total | Tr. | Tr. | 448 | 135 | | | | 583 |
| 1967: | | | | | | | | |
| Bottomfish | 1 | 1 | 750 | 178 | Tr. | | | 930 |
| Herring | (?) | | 33 | | | | | 33 |
| Total | 1 | 1 | 783 | 178 | Tr. | | | 963 |
| 1968: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 918 | 134 | 1 | | | 1,053 |
| Herring | (?) | | 45 | 22 | | | | 67 |
| Total | Tr. | Tr. | 963 | 156 | 1 | | | 1,120 |
| 1969: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 1,073 | 186 | 11 | | | 1,270 |
| Herring | (?) | | 36 | 94 | | | | 130 |
| Total | Tr. | Tr. | 1,109 | 280 | 11 | | | 1,400 |
| 1970: | | | | | | | | |
| Bottomfish | Tr. | 1 | 1,480 | 232 | 5 | | | 1,718 |
| Herring | (?) | | 28 | 117 | | | | 145 |
| Total | Tr. | 1 | 1,508 | 349 | 5 | | | 1,863 |
| 1971: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 1,806 | 397 | 10 | | | 2,213 |
| Herring | (?) | | 23 | 23 | | | | 46 |
| Total | Tr. | Tr. | 1,829 | 420 | 10 | | | 2,259 |
| 1972: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 1,917 | 412 | 9 | | | 2,338 |
| Herring | (?) | | 6 | 54 | | | | 60 |
| Total | Tr. | Tr. | 1,923 | 466 | 9 | | | 2,398 |
| 1973: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 1,755 | 348 | 7 | Tr. | | 2,110 |
| Herring | (?) | | 2 | 34 | Tr. | | | 36 |
| Total | Tr. | Tr. | 1,757 | 382 | 7 | Tr. | | 2,146 |
| 1974: | | | | | | | | |
| Bottomfish | Tr. | Tr. | 1,574 | 436 | 34 | | Tr. | 2,044 |
| Herring | (?) | (?) | 6 | 20 | Tr. | | | 26 |
| Total | Tr. | Tr. | 1,580 | 456 | 34 | | Tr. | 2,070 |

(2) *Japan.*—In keeping with the vast size of its operations, Japan employs more kinds of vessels and fishing gear than do the other nations which participate in the Bering Sea fisheries. There are four kinds of operations: a Mothership Fishery, North Pacific Trawl Fishery, Landbased Dragnet Fishery, and North Pacific Longline-Gillnet Fishery. Bottomfish are the primary target for all four fisheries.

The Mothership Fishery is licensed by Japan to fish only in the Bering Sea. It consists of several factoryships, each of which is accompanied by a fleet of catcher vessels. Catcher vessels servicing the motherships are Danish seiners, pair trawlers, or otter trawlers, with otter trawlers coming into increasing use in recent years. Otter trawlers tow a bag-shaped net whose mouth is held open vertically by floats on the head rope and weights on the foot rope and horizontally by so-called otter boards attached to or ahead of the wings of the net. Pair trawlers are simply two otter trawl vessels paired up to tow the same net. Danish seines differ from otter trawls primarily in the way they are set and hauled. Otter trawls are typically set directly off the stern and fished by the towing action of the vessel as it moves straight ahead. Danish seines are set on a triangular course, starting from and returning to an anchored buoy, and retrieved by winching the net in as the vessel slowly moves ahead (Alverson, et al., 1964).

Each mothership fleet consists of a factoryship, some of which are over 20,000 gross tons, which may be tended by up to about 30 catcher vessels. The mothership operations have changed from a short "fill-in" operation between salmon driftnet fishing in the spring and Antarctic whaling in the winter during the early period of the fishery to a year-around operation now. Over the years there has been some reduction in the numbers of catcher vessels assigned to each mothership but a great increase was achieved in the fishing power of individual catcher vessels as they became progressively larger and equipped with more powerful engines.

The North Pacific Trawl Fishery is carried out by trawlers operating independent of motherships and either offloading their catches to refrigerator transports or delivering the catches to Japan themselves. Since 1967, Japan has limited by license the number of vessels in this fishery to 42 at any one time; they may fish in waters east of 170° E and north of 10° N, which includes the Bering Sea, Aleutian Islands, and waters south and east off the Pacific Coast of the United States and Canada. Although some side trawlers were employed in this fishery in former years, fishing is now entirely by factory stern trawlers. A typical Japanese factory trawler now participating in the Bering Sea fishery is over 3,000 gross registered tons, and some exceed 5,000 gross tons with crews of 130 people or more.

As in the Mothership Fishery, there has been a major upgrading of the fleet over the years. This upgrading has been in terms of size of vessels; power of propulsion engines; and efficiency of fishing gear, navigation equipment, and fish-finding devices. For example, between 1967 and 1975 the average size of the factory trawlers employed in the North Pacific Trawl Fishery increased from about 1,500 gross tons to over 2,500 tons. The result of this upgrading has been a marked increase in the fishing power of the fleet which is not apparent when one considers just the numbers of vessels employed.

The landbased Dragnet Fishery ("hokutensen") is similar to the North Pacific Trawl Fishery in that the catcher vessels operate independent of motherships. Vessels licensed by Japan for the Landbased Dragnet Fishery are restricted to operating in waters north of 48° N latitude, east of 153° E longitude, and west of 170° W longitude. Most of the catch

by this fishery is from waters off Asia around Kamchatka and the northern Kuriles. Under terms of a bilateral agreement between the United States and Japan, the catch in 1975 and 1976 by the Landbased Dragnet Fishery off Alaska is limited to 35,000 mt (all species) in the eastern Bering Sea and 8,500 tons (all species) from the Aleutian Island area. Landbased dragnet vessels in current use are mostly stern trawlers, and limited by the Japanese Government to a maximum size of 349 gross registered tons.

Between 1961 and 1968 the fishing power of the Landbased Dragnet Fishery increased much more than the 3.5 fold increase in the number of vessels would indicate. In the earlier years most of the vessels were less than 100 gross tons and employed Danish seines. In contrast, almost all of the vessels are now of the 350 gross ton maximum size limit and most are stern trawlers which are generally more efficient than Danish seiners. As remarked earlier, vessels in the Landbased Dragnet Fishery deliver their catches to Japan rather than offloading to refrigerator transports.

Vessels are licensed separately by Japan to employ longlines for harvesting bottomfish. Pacific halibut was a primary target species off Japan's longline fishery west of 175° W longitude in the Bering Sea during the late 1950's and early 1960's and east of 175° W longitude for 2 years after 1962, when Japan was no longer required to abstain from fishing for Pacific halibut there under terms of the North Pacific Convention. As Japan's catches of halibut in the Bering Sea declined, the longliners increasingly switched to sablefish as the target species, first within the Bering Sea and later to the Gulf of Alaska.

TABLE 2.—*Number of vessels in Japanese fisheries and their catches from the Bering Sea and Aleutian Island region in thousands of metric tons. Years 1933–70 are calendar years; years 1971–75 are from Nov. 1 of preceding year to Oct. 31 of indicated year. Differences between catches shown here for the years 1971–74 and those in table 1 are due to use of calendar years in table 1 and "fishing years" here*

| | 1933 | 1934 | 1935 | 1936 | 1937 | 1940 | 1941 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mother ship: | | | | | | | | | | | | | | | |
| Number of mother ships | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 4 | 4 | 6 | 13 | 33 |
| Number of catcher vessels | 5 | 5 | 11 | 8 | 13 | 8 | 12 | 9 | 6 | 12 | 13 | 29 | 68 | 189 | 372 |
| Bottom fish catch | 3 | 15 | 29 | 27 | 43 | 10 | 12 | 10 | 9 | 23 | 24 | 48 | 160 | 449 | 539 |
| Herring catch | | | | | | | | | | | | | | + | 74 |
| North Pacific Trawl: | | | | | | | | | | | | | | | |
| Number of independent trawlers [1] | | | | | | | | 2 | 3 | 1 | | | 2 | | 3 |
| Bottom fish catch | | | | | | | | 2 | 6 | 2 | | | 2 | | 1 |
| Herring catch | | | | | | | | | | | | | | | + |
| North Pacific longline-gillnet: | | | | | | | | | | | | | | | |
| Number of longline-gillnet vessels [2] | | | | | | | | | | | | | | | |
| Bottom fish catch | | | | | | | | | | | | | | | |
| Herring catch | | | | | | | | | | | | | | | |
| Land-based dragnet: | | | | | | | | | | | | | | | |
| Number of vessels [3] | | | | | | | | | | | | | | | 54 |
| Bottom fish catch | | | | | | | | | | | | | | | |
| Herring catch | | | | | | | | | | | | | | | |
| Total catch by all gear: | | | | | | | | | | | | | | | |
| Bottom fish | 3 | 15 | 29 | 27 | 43 | 10 | 12 | 12 | 15 | 25 | 24 | 48 | 162 | 449 | 540 |
| Herring | | | | | | | | | | | | | | | 74 |

| | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 [4] | 1972 [4] | 1973 [4] | 1974 [4] | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mother ship: | | | | | | | | | | | | | | |
| Number of mother ships | 23 | 19 | 14 | 13 | 14 | 14 | 12 | 11 | 10 | 11 | 10 | 10 | 10 | 8 |
| Number of catcher vessels | 290 | 254 | 202 | 172 | 159 | 172 | 167 | 172 | 137 | 161 | 144 | 121 | 134 | 117 |
| Bottom fish catch | 471 | 225 | 339 | 326 | 390 | 705 | 774 | 818 | 1,180 | 1,233 | 1,287 | 1,099 | 950 | [5] |
| Herring catch | 10 | 32 | 43 | 36 | 28 | 33 | 23 | 12 | 11 | | | | | [5] |
| North Pacific trawl: | | | | | | | | | | | | | | |
| Number of independent trawlers [1] | 2 | 2 | 2 | 2 | 2 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 |
| Bottom fish catch | 6 | 9 | 10 | 16 | 14 | 11 | 93 | 204 | 243 | 493 | 560 | 602 | 505 | [5] |
| Herring catch | | | | | | | 21 | 22 | 16 | | | | | [5] |
| North Pacific longline-gillnet: | | | | | | | | | | | | | | |
| Number of longline-gillnet vessels [2] | | | | | | 22 | 22 | 21 | 22 | 22 | 22 | 22 | 22 | 22 |
| Bottom fish catch | | | | | | | 1 | 1 | 1 | 6 | 2 | 4 | 5 | [5] |
| Herring catch | | | | | | | | 1 | 1 | | | | | [5] |
| Land-based dragnet: | | | | | | | | | | | | | | |
| Number of vessels [3] | 70 | 93 | 103 | 126 | 172 | 173 | 184 | 182 | 182 | 182 | 182 | 182 | 183 | 182 |
| Bottom fish catch | 2 | 4 | 8 | 11 | 16 | 34 | 50 | 50 | 56 | 69 | 90 | 66 | 91 | [5] |
| Herring catch | | | | | | + | 1 | 1 | + | | | | | [5] |
| Total catch by all gear: | | | | | | | | | | | | | | |
| Bottom fish | 479 | 238 | 357 | 353 | 420 | 750 | 918 | 1,073 | 1,480 | 1,801 | 1,939 | 1,771 | 1,551 | [5] |
| Herring | 10 | 32 | 43 | 36 | 28 | 33 | 45 | 36 | 28 | | | | | [5] |

[1] Number of vessels licensed to fish east of 170° longitude and north of 10° N. latitude, which includes waters to the east and south of the Bering Sea.
[2] Licensed to fish in Bering Sea and to south and east off the United States and Canada. Comparatively little fishing was done by this fleet in the Bering Sea.
[3] Number of vessels licensed for eastern and western North Pacific. Numbers that fished in Bering Sea are unknown but were only a fraction of those licensed.
[4] Combined bottom fish and herring catch.
[5] Not available.

Although bottomfish are the main target of all four kinds of Japanese fishing operations in the Bering Sea, some Pacific herring also are taken by each of the fisheries. Largest catches of herring are by the Mothership Fishery and North Pacific Trawl Fishery, but the value of herring caught by gillnets is greater than the comparatively small catches would suggest because the fish are taken for their valuable roe just prior to spawning. Catches of herring by the Landbased Dragnet Fishery are so small as to be viewed as being incidental to other target species.

Development of the different kinds of Japanesese fishing operations in the Bering Sea can be traced in Table 2. It was not until the late 1960's that other than mothership operations became significant, but the Mothership Fishery is still the dominant operation.

The North Pacific Trawl Fishery began in earnest in 1968 and catches increased dramatically from about 100,000 mt in that year to almost one-half million tons in 1971, just 3 years later. The Landbased Dragnet Fishery is very important in the western Pacific off Kamchatka and the Kurile Islands; however, in the eastern Bering Sea the catches by that fishery have not exceeded 100,000 tons in any year. Fishing by the North Pacific Longline-Gillnet fleet largely has been in the northeastern Pacific Ocean (mainly Gulf of Alaska), as reflected by the small catches shown in Table 2 for the Bering Sea.

During the entire period 1933–1974, Japanese vessels harvested a total of 14.9 million mt of bottomfish and herring from the Bering Sea and Aleutian Island regions. Over 97 percent of the total was from the Bering Sea with less than 3 percent coming from the Aleutian Island region. By kind of fishing operation, the Mothership Fishery accounted for 77.1 percent of Japan's total catch of bottomfish and herring during the period 1933–1975, North Pacific Trawl Fishery 19.0 percent, Landbased Dragnet Fishery 3.7 percent, and North Pacific Longline-Gillnet Fishery only 0.2 percent.

(3) *U.S.S.R.*—In 1959 the U.S.S.R. initiated winter fisheries for flounders and herring in the eastern Bering Sea. Both fisheries were at least in partial response to declining catches in the Soviet Far East. Declining production from its traditional herring and flounder fisheries in the eastern Bering Sea led the U.S.S.R. to seek other species as well as to send parts of its fleet to fishing grounds to the south and east off the United States and Canada.

Within the Bering Sea, the most significant recent event has been the entry of the U.S.S.R. into the fishery for walleye pollock which was initiated by Japan. The first Soviet catch of walleye pollock was reported in 1969 when 27,000 mt were taken. The Soviet fishery for pollock thereafter assumed increasing importance, exceeding 300,000 mt in 1974. Other bottomfish which have been sought

by the Soviets in the Bering Sea include Pacific ocean perch, sablefish, Pacific cod, and grenadiers. The fishery for grenadiers is a comparatively recent development in deeper waters than the other species of bottomfish are generally taken.

As for Japan, the catches of bottomfish by the U.S.S.R. from the Aleutian Island area have been much smaller than from the Bering Sea. In terms of relative importance, however, the Aleutian Island area has contributed a larger fraction of the Soviet catch (11 percent of the combined Bering Sea-Aleutian Island total during 1959–1975) than the Japanese catch. The main target of the Soviet fishery around the Aleutians was rockfish (mainly Pacific ocean perch) until recent years when their declining abundance led to a diversion to other species, such as walleye pollock, Atka mackerel (*Pleurogrammus monopterygius*), and grenadiers. Soviet catches from the combined Bering Sea-Aleutian area during the period 1959–1975 are shown in Table 1.

Whereas Japan uses trawls, Danish seines, longlines, and gillnets for harvesting bottomfish and herring, all of the Soviet catch is taken by trawls. Soviet trawlers are either side trawlers or factory stern trawlers (Hitz, 1968). Three classes of side trawlers have been used. Smallest and oldest of the side trawlers is the SRT class of 265–335 gross tons and a crew of 22–26. Next largest of the side trawlers is the SRTR class of refrigerated medium trawlers of 505–630 gross tons and a crew of 26–28. Largest of the refrigerated side trawlers is the SRTM class of around 700 gross tons with a crew of about 30. In recent years a new class of stern ramp trawler, apparently designed as an improvement on the SRTM, has appeared off Alaska. These vessels, known as SRTK's are about 775 gross tons and reportedly have the same basic hull and general machinery below decks as SRTM's but above deck are redesigned for more efficient trawling over the stern. Factory stern trawlers are the largest and increasingly common kind of catcher vessel employed by the U.S.S.R. The so-called BMRT has been the most common factory stern trawler and is of 3,170 gross tons with a crew of about 90. A new class of factory stern trawlers, the RTM, has come into increasing use. It is of the same general size as a BMRT but has the advantage of a larger deck area aft for handling gear and fish. Several new classes of "supertrawlers" have been scheduled for serial production by the U.S.S.R. They will be from 4,000 to 5,500 gross tons, up to 7,000 horsepower, and with double the daily fish production and freezing capacity of the factory stern trawlers now being used by the Soviets.

The U.S.S.R., perhaps more than any other nation, relies on the expeditionary or flotilla concept in its fishing operations. This involves the deployment of a variety of vessels in close support of its catcher fleet. Support vessels include factoryships for receiving and processing catches; refrigerator transports to replenish stores aboard the catcher vessels and transport their catches to the homeland; oil tankers; personnel transports; tugs; patrol vessels; and, occasionally, even hospital ships. The refrigerator transports are of varied sizes with some upwards of 200 meters in length and 25,000 gross tons or more. A large refrigerator transport of 25,000 tons has a hold capacity to store about 12,000 tons of frozen products—which is equivalent to the capacity loads of about 13 BMRT's or RTM's, or 6 to 8 of the new supertrawlers recently ordered into production.

The Soviets rely more heavily on support vessels than does Japan. This appears to be mainly because the catches are not processed to as great an extent aboard Soviet vessels as aboard Japanese vessels. Aboard Japanese vessels the catches are typically processed into "surimi" (minced flesh), fillets, and fish meal; a smaller proportion of the catch is frozen in the round or in a headed and eviscerated form than on Soviet vessels. The more highly processed Japanese products occupy less space aboard the catcher vessels, which means they do not have to unload as frequently as Soviet vessels; hence there is less need for refrigerator transports to be used in support of Japanese fishing operations than for Soviet operations.

As was remarked to be the case for Japan, there also has been a substantial increase in the fishing power of the Soviet fleet. In Table 3 the numbers of Soviet vessels sighted by NMFS personnel off Alaska during the period 1963–1974 are shown along with their equivalent gross tonnages. A great increase in Soviet fishing power off Alaska is shown by the shift within the side trawler class from the use of small SRT's to large SRTM's and the increasing deployment of large factory stern trawlers. Factory stern trawlers now comprise over one-third of the Soviet cather fleet off Alaska compared to only about 9 percent of the fleet in 1963–1965. The gross tonnages for the combined classes of vessels are better measures of the fishing power than just the number of vessels. As can be seen from Table 3, the gross tonnage and, hence relative fishing power of the Soviet fleet, increases from an average level of 160,000 gross tons in 1963–1965 to an average level of 514,000 gross tons in 1972–1974. The figures in Table 3 are for all waters off Alaska but are indicative of the general situation which has occurred within the Bering Sea.

TABLE 3.—*Number and equivalent gross registered tonnage of different Soviet catcher vessels sighted off Alaska, 1963–74. Sightings were by NMFS personnel and do not include repeated sightings of the same vessels. Observations not extensive enough to provide comparative numbers in 1959–62 and unavailable for 1975*

| Year | Side trawlers | | | | | Factory stern trawlers | | | Equivalent gross tons, all classes |
|---|---|---|---|---|---|---|---|---|---|
| | SRT | SRTR | SRTM | SRTK | Total | BMRT | RTM | Total | |
| 1963 | 155 | 7 | | | 162 | 10 | 1 | 11 | 79,000 |
| 1964 | 237 | 9 | 12 | | 258 | 28 | 1 | 29 | 167,000 |
| 1965 | 330 | 11 | 25 | | 366 | 36 | 3 | 39 | 233,000 |
| 1966 | 248 | 9 | 44 | | 301 | 42 | 4 | 46 | 245,000 |
| 1967 | 191 | 7 | 66 | | 264 | 53 | 4 | 57 | 279,000 |
| 1968 | 97 | 5 | 90 | | 192 | 71 | 3 | 74 | 324,000 |
| 1969 | 66 | 9 | 127 | | 202 | 79 | 6 | 85 | 377,000 |
| 1970 | 65 | 11 | 144 | | 220 | 97 | 6 | 103 | 447,000 |
| 1971 | 92 | 7 | 102 | 2 | 203 | 102 | 5 | 107 | 438,000 |
| 1972 | 111 | 6 | 161 | 7 | 285 | 100 | 11 | 111 | 497,000 |
| 1973 | 25 | 7 | 155 | 9 | 196 | 105 | 15 | 120 | 498,000 |
| 1974 | 25 | 7 | 174 | 8 | 214 | 117 | 14 | 131 | 546,000 |

(4) *Other Nations.*—The first commercial fishery by South Korea was in 1967 when a refrigerator transport accompanied by eight pair trawlers was deployed to the eastern Bering Sea. These vessels fished for less than 1 week and only caught an estimated 100 tons of walleye pollock. The size of South Korea's fishing operations was increased in subsequent years and, by 1974, consisted of two factoryships—accompanied by a fleet of 29 dependent trawlers and eight longliners, whose catch was estimated to be 40,000 mt of bottomfish, mostly walleye pollock, but including about 3,000 tons of sablefish and 200 tons of herring. Catches were smaller in 1975 because of declines in demand and prices for fish coupled with increased operating costs. However, South Korea has announced its intention to increase its harvest of walleye pollock from the eastern Bering Sea in 1976 more than 100,000 mt over the 1975 level. Because South Korea has yet to provide the United States with statistics on its fishing operations off the Bering Sea and Pacific coasts of the United States, it has been necessary to estimate catches by its fleets from observations made by personnel of the Law Enforcement Division, NMFS.

Fishing by other nations in the eastern Bering Sea has been limited to exploratory probes by Taiwan and Poland. One Taiwanese stern trawler made three trips between December 1974 and May 1975 with a catch target of 2,250 mt. Taiwan has not provided the United States with statistics on its fishing operations. Poland has reported to the United States that one of its factory trawlers caught 393 tons of bottomfish in the eastern Bering Sea in 1973.

### D. IMPACTS ON DOMESTIC FISHERY

The kinds of impacts on domestic fisheries have been much the same from the distant-water fleets of all nations. Impacts have included the interferences with or destruction of longline and pot gear employed by United States halibut and crab fishermen, pre-emption of fishing grounds by the large foreign fleets, and the reduction in abundance of spe-

cies of current or potential interest to U.S. fishermen.

The impact on stocks of fish of current interest to United States fishermen have been largely confined to halibut and crab. Purposeful and incidental catches of Pacific halibut by the foreign fisheries have contributed to a large decline in that resource, with serious economic consequences to United States and Canadian setline fishermen. In the Bering Sea, the halibut catch by trawls generally is incidental, but the Japanese land-based dragnet fishery occasionally targets on halibut. The total halibut catch by foreign trawl fleets in the Bering Sea increased throughout the 1960's and peaked at an estimated 11,519 mt in 1971. The trawl catch declined during 1972–1974, and a further decline is expected in 1975–1976 as a result of trawl closures agreed to by Japan and the U.S.S.R. About 100 million snow (Tanner) crabs (*Chionoecetes* sp.) mostly of subcommercial sizes, are estimated by United States and Canadian observers to be taken annually as a by-catch in Japan's Bering Sea fishery for bottomfish. Most of the juvenile snow crab die even when they are returned to sea. An evaluation of the impact on the United States crab fishery of these large incidental catches must await knowledge of the rate of natural mortality in order to calculate how many would have been available for capture as adults in the United States crab fishery if they had not been killed by Japan's trawl fisheries.

Among the major concerns voiced by U.S. fishermen has been the possibility that foreign trawlers catch many salmon of U.S. origin. Only a few salmon have been observed in hundreds of trawl hauls examined by U.S. observers aboard Japanese vessels trawling in the Bering Sea in spring, summer, and fall. Considerably more salmon, as high as 150 fish per vessel per month, have been observed during trawling in winter along the 100 meter isobath from Unimak Island along the shelf north, and west to about 161° N latitude in the eastern Bering Sea. The vast majority of the salmon observed have been chinook salmon (*Oncorhynchus tshawytscha*), with only one or two chum salmon (*O. keta*) seen out of a total of perhaps 400 fish observed.

The foreign fisheries of the eastern Bering Sea and Aleutian Island area have impacted both indirectly and directly on the populations of marine mammals. A direct impact has been the increasing frequency that northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands have been observed to have scraps of fish netting, plastic wrapping bands, and other debris around their necks or otherwise entangled on their bodies. Most of the material must have been lost or deliberately discarded by the large foreign fishing fleets. Deaths of some fur seals are known to have resulted from entangling in such materials, but the total impact cannot yet be evaluated. An indirect impact of the fisheries would be in competing for some of the same species of fish and shellfish used as food by the northern fur seal and other marine mammals.

Among the many species of bottomfish present in the Bering Sea only Pacific halibut is now sought by United States fishermen. There are many reasons for this anomalous situation, including distance from United States markets and processing plants, but a contributing factor has been that foreign fishing had reduced stock densities of most of the desirable species to levels where they no longer are capable of yielding catch rates at which United States fishermen can afford to fish. The early foreign fisheries operated at high catch rates as a result of fishing on previously unutilized stocks. The effect of these high catch rates was to subsidize some of the costs required to develop the foreign harvesting and processing technology for utiliizing the resources. United States industry will not have the same advantage unless foreign fishing is reduced or stopped for a period of several years to allow the stocks to rebuild to higher levels of abundance.

Whereas the kinds of impacts on domestic fisheries have been much the same from the distant-water fleets of all nations, the degree of impact has been different between nations. This can be attributed to several factors, including differences in the size of the fishing and support operations by each nation; species sought; fishing gear and techniques used; and whether or not fisheries agreements have been signed with the United States and, if so, how well the agreements have been complied with.

Greatest impact from the standpoint of size of operations has been by Japan, followed by the U.S.S.R.—with South Korea a distant third and all other nations causing far less impact. Although Japan and the U.S.S.R. have tended to target on the same general species, the greater use of midwater trawling by the U.S.S.R. (and the U.S.S.R.'s tendency to seek certain species, such as grenadiers, in deep water) probably has resulted in a proportionately smaller Soviet by-catch of halibut and king crab (*Paralithodes camtschatica*), the species of most concern to United States fishermen. On the other hand, it appears from observations by NMFS Law Enforcement personnel that the Soviets frequently under-report their catches of bottomfish which means that the by-catch of halibut may be greater than inferred from official Soviet statistics.

The degree of compliance of Soviet vessels to agreements with the United States is much more difficult to evaluate than for Japan. Japan has agreed not to retain trawl-caught halibut east of 175° W longitude except in International North Pacific Fisheries Commission (INPFC) Area D when they may be retained during a short period in the spring. United States and Canadian personnel are allowed on some Japanese vessels to routinely observe operations and, in effect, evaluate the compliance or non-compliance with the agreements. The U.S.S.R. has not agreed to refrain from fishing for Pacific halibut but says its vessels do not target on halibut or take many as a by-catch. Few United States or Canadian observers have been allowed on Soviet vessels to check these statements and, on the few occasions they were permitted aboard Soviet vessels in the Bering Sea, felt that the activities were research in character and therefore not representative of commercial operations.

Overfishing is the most difficult of all impacts to evaluate, particularly in regard to those nations which do not provide the United States with any statistics on their fishing operations or those nations providing statistics of limited usefulness. Although vessels from South Korea first began fishing in the Bering Sea in 1967, no statistics had been provided to the United States on its operations to the time of this writing (July 1976), nor has Taiwan provided any data on its catches. The U.S.S.R. began fishing in the Bering Sea in 1959, but only began providing the United States with catch and effort data in 1967. Japan has furnished us with catch records from the inception in 1954 of its post-World War II fishery in the Bering Sea. Statistics provided to the United States by Japan have been among the most detailed and useful that are compiled by any nation in the world.

For lack of adequate statistics on catches and fishing effort from all nations participating in the Bering Sea fisheries for bottomfish and herring, it has been difficult, and for some species impossible, to adequately assess the effects of fishing. This situation has been aggravated by the pulse nature of the distant-water fisheries which have tended to generate massive fishing effort on localized stocks and thereby rapidly reduce their abundance. United States investigators often have not been aware that this process was occurring until after the foreign fleets had abandoned their operations to move on to other stocks, species, or fishing grounds. Some improvement has occurred in recent years with the incorporation of safeguards into the fisheries agreements with Japan and the U.S.S.R. in the nature of quotas on the catches of some species, provisions not to target on other species, as well as certain time-area and gear restrictions.

E. REGULATORY HISTORY AND VIOLATIONS

(1) *Fishery Restrictions.*—(a) *United States.* Fishery restrictions on U.S. nationals are those established by the State of Alaska and those promulgated by the Internatoinal Pacific Halibut Commission (IPHC), for the taking of Pacific halibut. The State of Alaska requires all commercial fishermen landing any species of fish or shellfish in Alaska to possess a commercial fishing license and the captain or operator-owner of all fishing vessels are required to license their vessels and the fishing gear employed. Buyers are required to keep records of each purchase and show the number and name of the vessel, the State license number of the vessel, date of landing, pounds

purchased or each species, statistical area in which the fish were caught, and the kind of gear used in taking the fish. There are no other substantive regulations by the State of Alaska on the taking of bottomfish, other than Pacific halibut, in the Bering Sea and Aleutian Island area.

Restrictions by the IPHC on the taking of Pacific halibut pertain to licenses, gear, size limits, seasons, closed nursery grounds, and catch quotas. Licenses issued by the IPHC are required for all vessels fishing for halibut except those less than 5 net tons or vessels which use hook and line gear other than setlines. As regards both commercial and sport gear, only hook and line gear is authorized by the IPHC for the taking of halibut.

(b) *Foreign nations.* The two kinds of fishery restrictions placed on foreign nations have been: (1) U.S. law establishing a 12-mile contiguous fishing zone (CFZ) within which all foreign fishing and activities in support of fishing are prohibited. This law was approved on October 14, 1966. Prior to then foreign fishing was prohibited within U.S. territorial waters which extend three miles from shore.

Enforcement of the CFZ and territorial waters is accepted by nations fishing off the U.S. as a U.S. right and responsibility.

(2) Provisions contained in bilateral and other agreements signed by foreign nations with the U.S. These provisions usually have been agreed to through a negotiating process in which concessions have been made by foreign governments to U.S. fishery interests in exchange for concessions granted by the U.S. to the fishery interests of other nations. Concessions granted by the U.S. have been in the nature of permission to fish or carry out activities in support of fishing at certain times and places within the CFZ. Concessions granted by foreign nations have been in the form of agreement not to fish at certain times and places on the high seas outside the CFZ, not to target on certain species, and not to exceed certain levels of catch (catch quotas).

Enforcement of the provisions of bilateral and other agreements and the penalties imposed for violations is the responsibility of the individual nations. For example, the U.S.S.R. is responsible for enforcing and imposing penalties on its own nationals for violations of provisions relating to fishing activities on the high seas, outside the U.S. CFZ.

Several restrictions on foreign nations in the form of catch quotas and area-time closures have been in effect in the eastern Bering Sea and Aleutian Island region in recent years. Annual catch quotas, in metric tons, for Japanese and Soviet fisheries for 1974–1976 are as follows:

| Area and fishery | Species | 1973 | 1974 | 1975–76 |
|---|---|---|---|---|
| **Japan** | | | | |
| Eastern Bering Sea mother ship—North Pacific trawl | Pollock | 1,500,000 | 1,300,000 | 1,100,000 |
| | Ground fish other than pollock. | | | 160,000 |
| | Herring | [1] (33,000) | [1] (33,000) | 15,000 |
| North Pacific long-line gill net | Herring | [2] (4,600) | [2] (4,600) | 3,000 |
| Land-based dragnet | Ground fish (all species) | | | 35,000 |
| Aleutian region: | | | | |
| Mother ship—North Pacific trawl, and Long-line gill net. | Pacific Ocean perch | | | 9,600 |
| | Sablefish | | | 1,200 |
| Land-based dragnet | Ground fish (all species) | | | 8,500 |
| **U.S.S.R.** | | | | |
| Eastern Bering Sea | Flatfish | 100,000 | | [3] |
| | Pollock | | | 210,000 |
| | Herring | | | 30,000 |
| | Other species | | | 120,000 |
| Aleutian region | Rockfish | | | 12,000 |
| | Other species | | | 16,000 |

[1] 1969 level.
[2] 1971 level.
[3] Included in other species.

Area-time closures currently in effect for Japanese and Soviet trawl fisheries in the southeastern Bering Sea are shown in Figures 1 and 2. Other provisions relating to Japanese and Soviet fisheries are shown in Figures 3 and 4.

Restrictions on fishing by Polish vessels in the eastern Bering Sea and Aleutian Island region are shown in Figure 5.

Major provisions of the U.S. fisheries agreement with South Korea are shown in Figure 6.

No official fisheries agreements have been signed with Taiwan.

(2) *Violations and Gear Losses*—Violations and gear losses off Alaska can be categorized as (1) violations of international agreements, (2) violations of U.S. waters and continental shelf resources, and (3) losses of crab pots and halibut skates to foreign fisheries. For convenience these violations and gear losses are summarized below according to nation. Not included in the following summaries are violations by foreign vessels fishing for crab, shrimp, or salmon, which will be discussed in the preliminary management plans for those fisheries.

A summary of violations of U.S. waters and continental shelf resources is provided in Table 4.

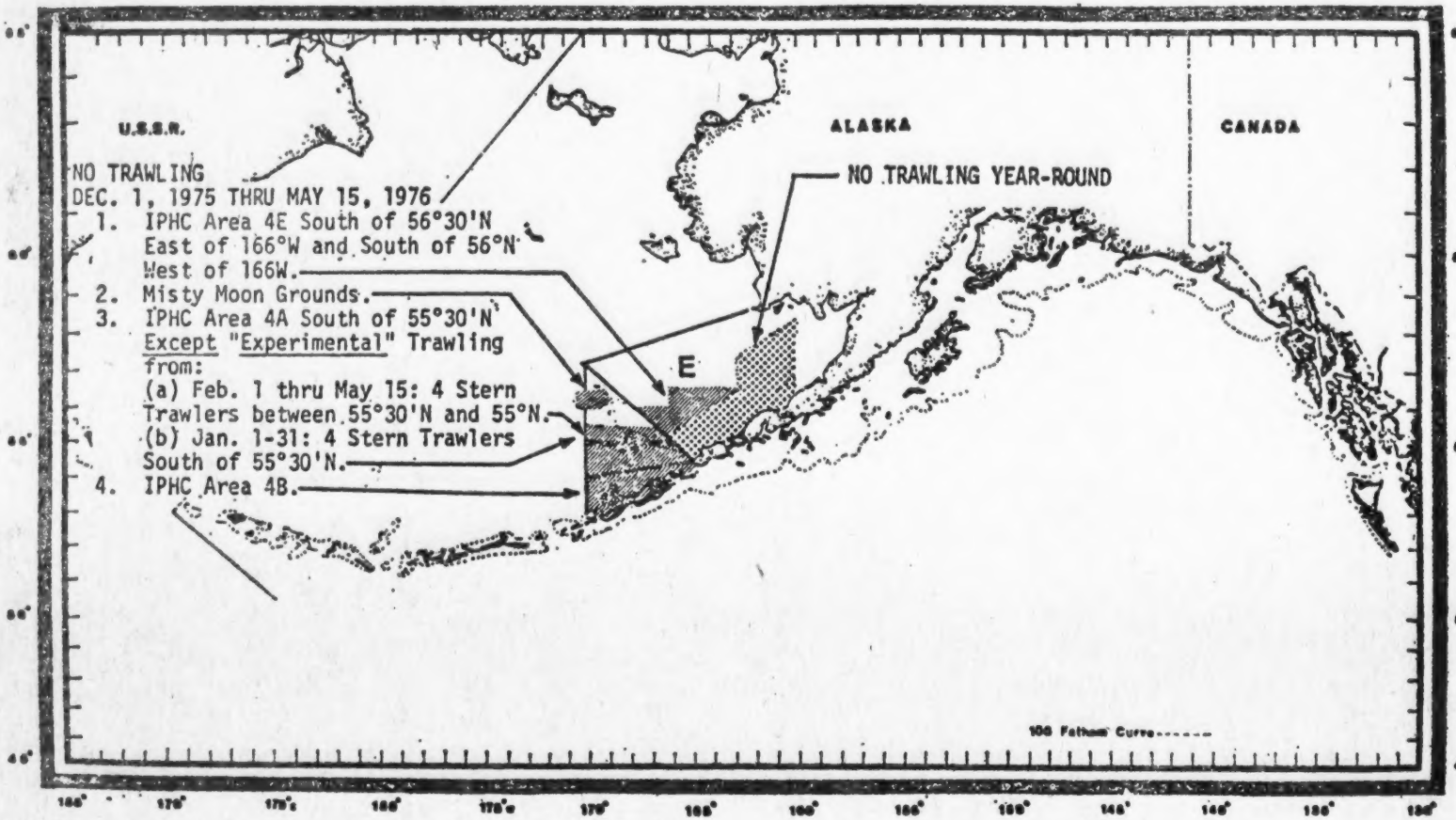
U.S.S.R.
ALASKA
CANADA
NO TRAWLING
DEC. 1, 1975 THRU MAY 15, 1976
1. IPHC Area 4E South of 56°30'N East of 166°W and South of 56°N West of 166W.
2. Misty Moon Grounds.
3. IPHC Area 4A South of 55°30'N Except "Experimental" Trawling from:
(a) Feb. 1 thru May 15: 4 Stern Trawlers between 55°30'N and 55°N.
(b) Jan. 1-31: 4 Stern Trawlers South of 55°30'N.
4. IPHC Area 4B.
NO TRAWLING YEAR-ROUND
E
100 Fathom Curve

Figure 1.--Area-time closures and restrictions for Japanese trawl fisheries in southeastern Bering Sea, effective through December 31, 1976.

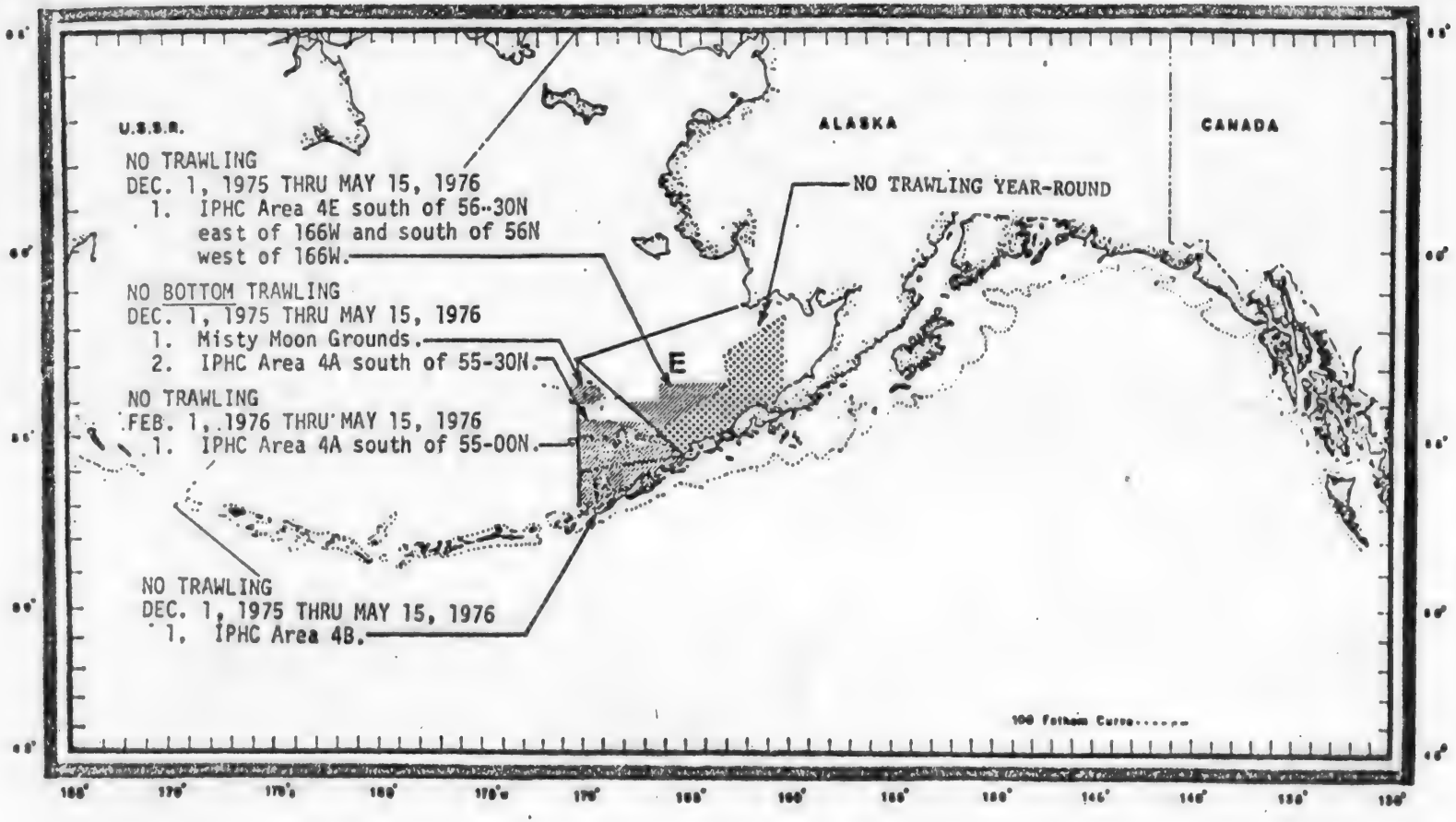
U.S.S.R.
ALASKA
CANADA
NO TRAWLING
DEC. 1, 1975 THRU MAY 15, 1976
1. IPHC Area 4E south of 56-30N
east of 166W and south of 56N
west of 166W.
NO TRAWLING YEAR-ROUND
NO BOTTOM TRAWLING
DEC. 1, 1975 THRU MAY 15, 1976
1. Misty Moon Grounds.
2. IPHC Area 4A south of 55-30N.
E
NO TRAWLING
FEB. 1, 1976 THRU MAY 15, 1976
1. IPHC Area 4A south of 55-00N.
NO TRAWLING
DEC. 1, 1975 THRU MAY 15, 1976
1. IPHC Area 4B.
100 Fathom Curve

Figure 2.--Area-time closures and restrictions for Soviet trawl fisheries in southeastern Bering Sea, effective through December 31, 1976.

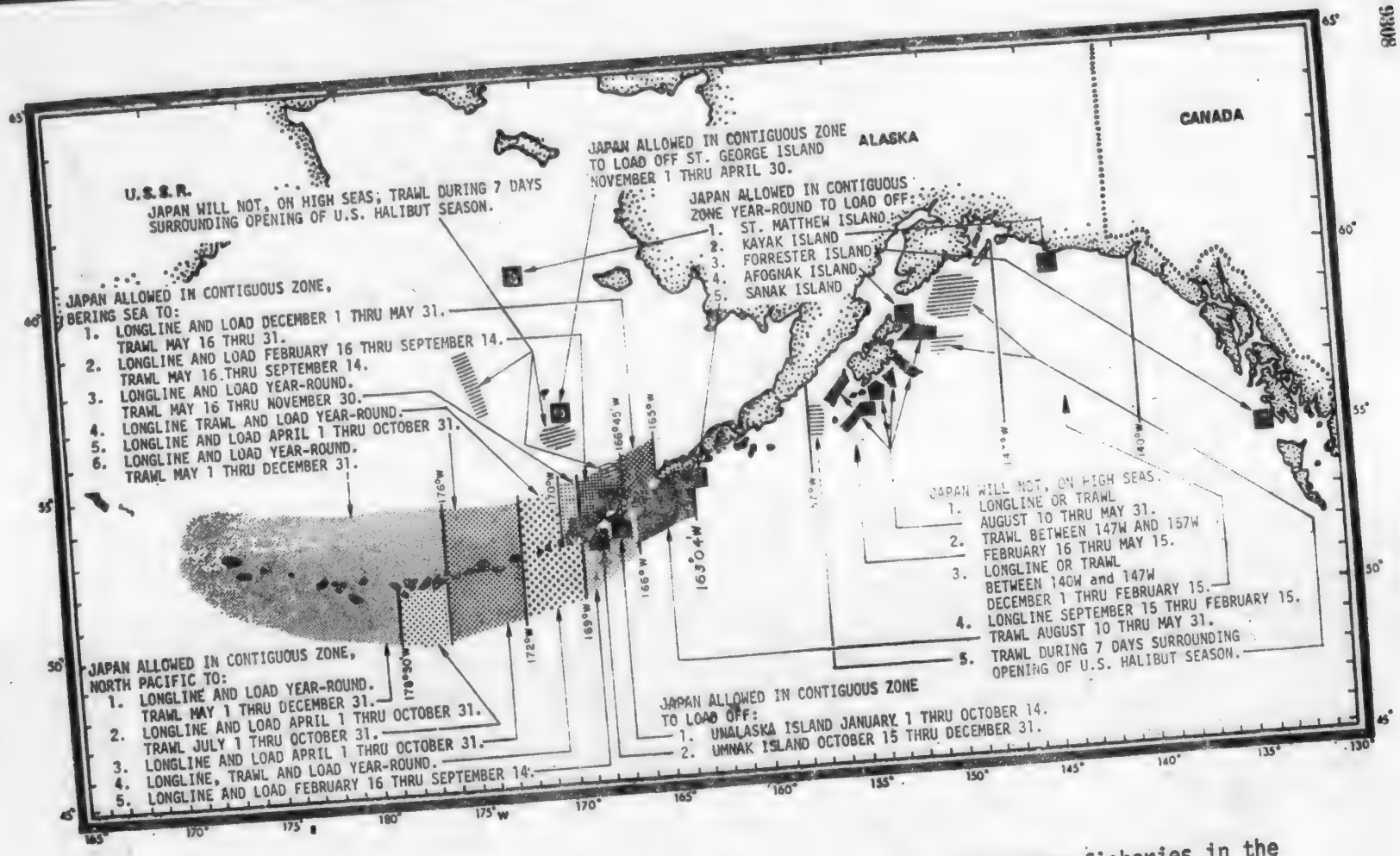
U.S.S.R.
JAPAN WILL NOT, ON HIGH SEAS, TRAWL DURING 7 DAYS SURROUNDING OPENING OF U.S. HALIBUT SEASON.
JAPAN ALLOWED IN CONTIGUOUS ZONE, BERING SEA TO:
1. LONGLINE AND LOAD DECEMBER 1 THRU MAY 31.
TRAWL MAY 16 THRU 31.
2. LONGLINE AND LOAD FEBRUARY 16 THRU SEPTEMBER 14.
TRAWL MAY 16 THRU SEPTEMBER 14.
3. LONGLINE AND LOAD YEAR-ROUND.
TRAWL MAY 16 THRU NOVEMBER 30.
4. LONGLINE TRAWL AND LOAD YEAR-ROUND.
5. LONGLINE AND LOAD APRIL 1 THRU OCTOBER 31.
6. LONGLINE AND LOAD YEAR-ROUND.
TRAWL MAY 1 THRU DECEMBER 31.
JAPAN ALLOWED IN CONTIGUOUS ZONE, NORTH PACIFIC TO:
1. LONGLINE AND LOAD YEAR-ROUND.
TRAWL MAY 1 THRU DECEMBER 31.
2. LONGLINE AND LOAD APRIL 1 THRU OCTOBER 31.
TRAWL JULY 1 THRU OCTOBER 31.
3. LONGLINE AND LOAD APRIL 1 THRU OCTOBER 31.
4. LONGLINE, TRAWL AND LOAD YEAR-ROUND.
5. LONGLINE AND LOAD FEBRUARY 16 THRU SEPTEMBER 14.
JAPAN ALLOWED IN CONTIGUOUS ZONE TO LOAD OFF ST. GEORGE ISLAND NOVEMBER 1 THRU APRIL 30.
ALASKA
CANADA
JAPAN ALLOWED IN CONTIGUOUS ZONE YEAR-ROUND TO LOAD OFF:
1. ST. MATTHEW ISLAND
2. KAYAK ISLAND
3. FORRESTER ISLAND
4. AFOGNAK ISLAND
5. SANAK ISLAND
JAPAN WILL NOT, ON HIGH SEAS.
1. LONGLINE OR TRAWL AUGUST 10 THRU MAY 31.
2. TRAWL BETWEEN 147W AND 157W FEBRUARY 16 THRU MAY 15.
3. LONGLINE OR TRAWL BETWEEN 140W and 147W DECEMBER 1 THRU FEBRUARY 15.
4. LONGLINE SEPTEMBER 15 THRU FEBRUARY 15. TRAWL AUGUST 10 THRU MAY 31.
5. TRAWL DURING 7 DAYS SURROUNDING OPENING OF U.S. HALIBUT SEASON.
JAPAN ALLOWED IN CONTIGUOUS ZONE TO LOAD OFF:
1. UNALASKA ISLAND JANUARY 1 THRU OCTOBER 14.
2. UMNAK ISLAND OCTOBER 15 THRU DECEMBER 31.
163°04'W
165°W
166°45'W
166°W
169°W
170°W
172°W
176°W
178°30'W
140°W
147°W
157°W
65°
60°
55°
50°
45°
130°
135°
140°
145°
150°
155°
160°
165°
170°
175° W
180°
175° E
170°
165°

Figure 3.--Area-time closures and restrictions for Japanese trawl and longline fisheries in the Gulf of Alaska, effective through December 31, 1976.

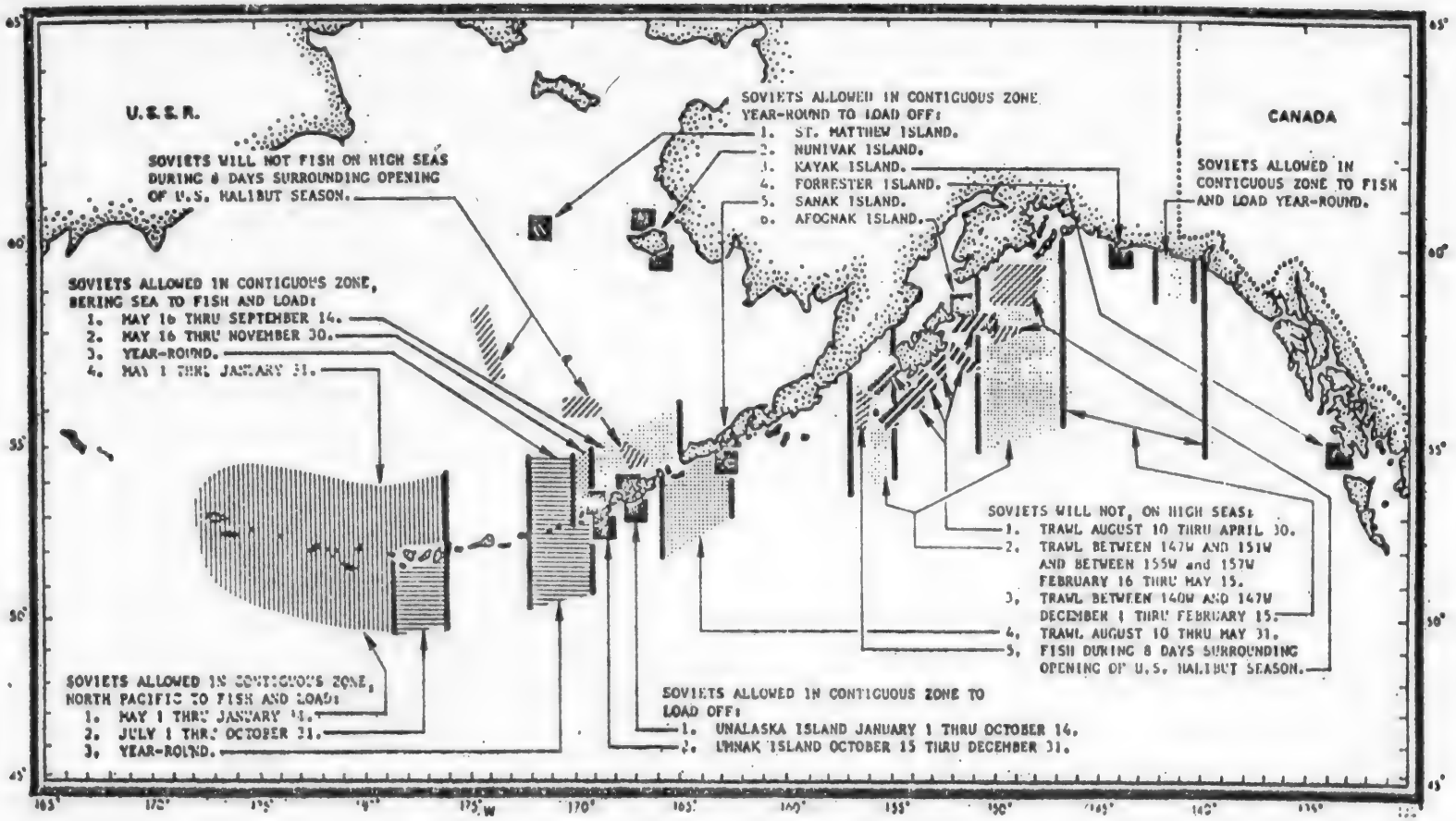
U.S.S.R.
CANADA
SOVIETS WILL NOT FISH ON HIGH SEAS DURING 8 DAYS SURROUNDING OPENING OF U.S. HALIBUT SEASON.
SOVIETS ALLOWED IN CONTIGUOUS ZONE YEAR-ROUND TO LOAD OFF:
1. ST. MATTHEW ISLAND.
2. NUNIVAK ISLAND.
3. KAYAK ISLAND.
4. FORRESTER ISLAND.
5. SANAK ISLAND.
6. AFOGNAK ISLAND.
SOVIETS ALLOWED IN CONTIGUOUS ZONE TO FISH AND LOAD YEAR-ROUND.
SOVIETS ALLOWED IN CONTIGUOUS ZONE, BERING SEA TO FISH AND LOAD:
1. MAY 16 THRU SEPTEMBER 14.
2. MAY 16 THRU NOVEMBER 30.
3. YEAR-ROUND.
4. MAY 1 THRU JANUARY 31.
SOVIETS WILL NOT, ON HIGH SEAS:
1. TRAWL AUGUST 10 THRU APRIL 30.
2. TRAWL BETWEEN 147W AND 151W AND BETWEEN 155W and 157W FEBRUARY 16 THRU MAY 15.
3. TRAWL BETWEEN 140W AND 147W DECEMBER 1 THRU FEBRUARY 15.
4. TRAWL AUGUST 10 THRU MAY 31.
5. FISH DURING 8 DAYS SURROUNDING OPENING OF U.S. HALIBUT SEASON.
SOVIETS ALLOWED IN CONTIGUOUS ZONE, NORTH PACIFIC TO FISH AND LOAD:
1. MAY 1 THRU JANUARY 31.
2. JULY 1 THRU OCTOBER 31.
3. YEAR-ROUND.
SOVIETS ALLOWED IN CONTIGUOUS ZONE TO LOAD OFF:
1. UNALASKA ISLAND JANUARY 1 THRU OCTOBER 14.
2. UMNAK ISLAND OCTOBER 15 THRU DECEMBER 31.
65°
60°
55°
50°
45°
175° W
170°
165°
160°
155°
150°
145°
140°
135°

Figure 4.--Area-time closures and restrictions for Soviet trawl fisheries in the Gulf of Alaska, effective through December 31, 1976.

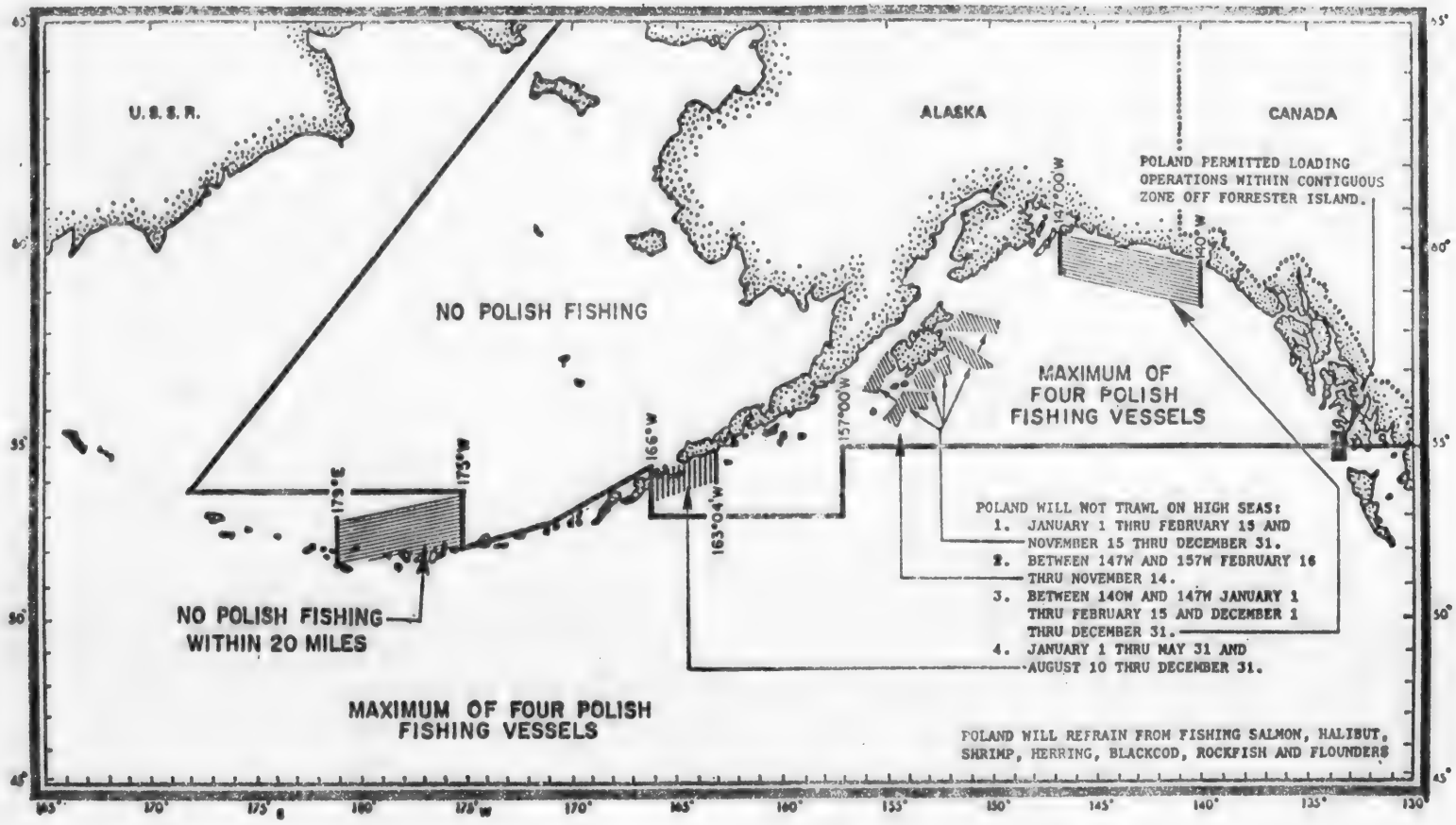
U.S.S.R.
ALASKA
CANADA
POLAND PERMITTED LOADING OPERATIONS WITHIN CONTIGUOUS ZONE OFF FORRESTER ISLAND.
NO POLISH FISHING
MAXIMUM OF FOUR POLISH FISHING VESSELS
NO POLISH FISHING WITHIN 20 MILES
MAXIMUM OF FOUR POLISH FISHING VESSELS
POLAND WILL NOT TRAWL ON HIGH SEAS:
1. JANUARY 1 THRU FEBRUARY 15 AND NOVEMBER 15 THRU DECEMBER 31.
2. BETWEEN 147W AND 157W FEBRUARY 16 THRU NOVEMBER 14.
3. BETWEEN 140W AND 147W JANUARY 1 THRU FEBRUARY 15 AND DECEMBER 1 THRU DECEMBER 31.
4. JANUARY 1 THRU MAY 31 AND AUGUST 10 THRU DECEMBER 31.
POLAND WILL REFRAIN FROM FISHING SALMON, HALIBUT, SHRIMP, HERRING, BLACKCOD, ROCKFISH AND FLOUNDERS
179°E
175°W
166°W
163°04'W
157°00'W
147°00'W
140°W

Figure 5.--Area-time closures and restrictions for fisheries of the Polish People's Republic in the Gulf of Alaska, effective through December 31, 1976.

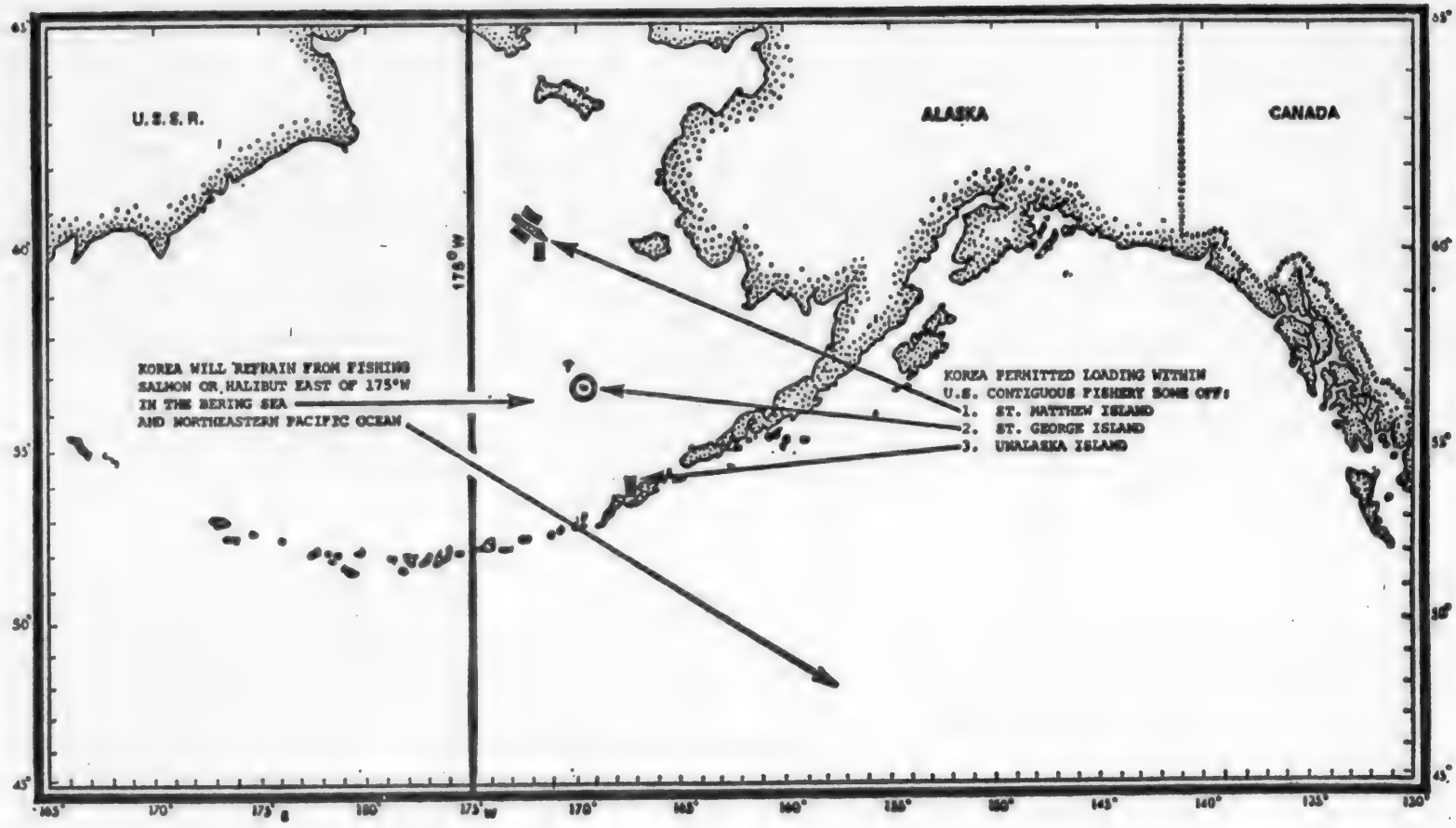


Figure 6.--Provisions of the United States-Republic of Korea Fisheries Agreement effective through December 12, 1977.

TABLE 4.—*Number of documented violations by foreign vessels of U.S. waters and continental shelf resources in the Bering Sea and Aleutian Islands, 1961–April 1976*

| Nation: | Number of violations |
|---|---|
| U.S.S.R | 3 |
| Japan | 11 |
| South Korea | ----- |
| Taiwan | ----- |
| Canada | 1 |
| Total | 15 |

As may be seen in the preceding table, Japan accounted for 11, or 74 percent, of the documented violations. Considering the large size of its fishing operations, only three violations by the U.S.S.R. is a surprisingly small number. The 11 violations by Japan consisted of 6 CFZ violations by trawlers fishing for groundfish in Aleutian Island waters, 2 CFZ violations by longliners fishing for sablefish in Aleutian Island waters, and 1 violation by a trawler retaining king crab in violation of the continental shelf resource provision. Two of the three violations by the U.S.S.R. were of the CFZ by trawlers fishing for groundfish in Aleutian Island waters; the other was a CFZ violation in Norton Sound in support of the Soviet herring fishery. The single violation by Canada was a longliner fishing in U.S. territorial waters.

A summary of the violations of international agreements is provided in Table 5.

TABLE 5.—*Number of documented violations of international agreements by foreign vessels, Bering Sea and Aleutian Islands, 1961–April 1976*

| Nation: | Number of violations |
|---|---|
| U.S.S.R. | 6 |
| Japan | 2 |
| Canada | 2 |
| Total | 10 |

The six violations by the U.S.S.R. were trawling in the Unimak pot sanctuary. The two violations by Japan were for possession of Pacific halibut by a longliner in an area closed to halibut fishing and for retention of halibut by a trawler. Both violations by Canadian vessels were for longlining for Pacific halibut in closed areas or seasons.

The numbers of U.S. crab pots reported as having been lost to foreign fishing vessels are summarized in Table 6 according to nation causing the losses.

TABLE 6.—*Number of U.S. crab pots reported lost in Bering Sea and Aleutian Island to foreign vessels, 1963–April 1976*

| Nation causing loss: | Number of pots lost |
|---|---|
| U.S.S.R. | 107 |
| Japan | 31 |
| South Korea | 30 |
| Unknown | [1] 168 |

[1] Including 85 believed lost to Soviet vessels, 19 to Japanese vessels, and 2 to Japanese or South Korean vessels.

As can be seen from Table 6, Soviet vessels have accounted for a very high proportion of the losses of U.S. crab pots in both the Bering Sea and Aleutian Islands. Also of significance is that vessels of South Korea have accounted for almost as many losses of crab pots as have Japanese vessels; yet, the Japanese fishery dwarfs that of South Korea and, in fact, has been much larger in the Bering Sea than that of the U.S.S.R. Not shown in the above table is the great reduction in the number of pot losses that has occurred in recent years.

The number of skates of halibut gear reported as having been lost by North American fishermen are summarized in Table 7 according to nation causing the losses. Not shown in the table, but as also noted for crab pots, there has been a significant reduction in the loss of halibut gear in recent years.

TABLE 7.—*Number of skates of halibut gear lost in Bering Sea and Aleutian Islands by North American fishermen, 1963–April 1976*

| Nation causing loss: | Number of skates lost |
|---|---|
| U.S.S.R | 15 |
| Japan | 69 |
| South Korea | — |
| Unknown | — |
| Total | 84 |

As shown in Table 7, Japanese vessels have caused the most losses of halibut gear, as opposed to the situation for crab pots.

F. COOPERATIVE RESEARCH AND STATISTICAL EXCHANGE

(1) *Cooperative Research*—Several kinds of cooperative research have been carried out on the bottomfish and herring resources and fisheries of the Bering Sea-Aleutian Island region. The major kinds of cooperative research have been:

(a) Visits of U.S. and foreign scientists in laboratories and aboard vessels of the other country to become familiar with each other's research techniques, goals, and results.

(b) Exchange of scientific samples, data, and technical papers.

(c) Meetings of scientists to discuss results of research and to plan for future studies.

(d) Sampling by U.S. observers of commercial catches aboard foreign vessels.

(e) Joint operations of research vessels in cooperatively designed field programs.

All of the above kinds of cooperative research have been carried out with Japan. A large number of tangible benefits have accrued to the U.S., and for the past several years has included extensive at-sea sampling by U.S. observers aboard Japanese motherships and factory trawlers operating in the Bering Sea. Cooperative research with Japan has been facilitated by the existence of the International North Pacific Fisheries Commission, which has served as a forum for discussions and exchanges of data and reports between the scientists of the U.S., Canada, and Japan.

Cooperative research with the U.S.S.R. has been at a much lower level of activity than with Japan and has produced far fewer tangible results of benefit to the U.S. Of the several attempts at joint field activities in the Bering Sea-Aleutian Island region, none have been particularly successful. Cooperative bottomfish surveys by research vessels of the U.S. and U.S.S.R. have either failed to take place, have had to be substantially modified by the U.S. at the last minute with resultant loss of desired coverage, or basic data collected by Soviet scientists have not been made available to the U.S. at the end of the field season. An exception was a cooperative halibut tagging program in which the U.S.S.R. made one of its vessels available to personnel of the International Pacific Halibut Commission who tagged and released several hundred halibut in the western Bering Sea.

The major obstacle to meaningful cooperative research with the U.S.S.R. has been the absence of a set of mutually agreed upon objectives and priorities and a forum which allows as much dialogue as necessary to arrange the complicated logistics of joint field activity and agreed upon approaches to reaching mutual objectives.

Cooperative research with South Korea, the other major participant in the bottomfish fishery, has consisted of having an investigator from that Country spend a few weeks in Seattle, Washington, at the NMFS Northwest Fisheries Center and aboard a NOAA research vessel to become somewhat familiar with procedures used by U.S. investigators. Limited discussions have been held between U.S. and South Korean investigators at three technical workshops. At these workshops the South Koreans have had nothing substantive to report in the way of research conducted on the bottomfish resources of the Bering Sea-Aleutian Island region.

(2) *Exchange of Statistics on Fishing Operations.*—Statistics made available to the U.S. by Japan on its fishing operations have been among the most detailed and complete collected by any nation in the world. The statistics provided by Japan give much detail on area of origin of catches, species caught, size and kind of vessels used, fishing gear employed, and time period. An exception to this general rule has been for Japan's Land-based Dragnet Fishery. Statistics on that fishery have not been as timely, detailed, or complete as those provided by Japan on its other fisheries. This appears to reflect the fact that they have been collected at the provincial level in Japan, rather than by the Fisheries Agency of Japan, as has been the case for the other fisheries.

Statistics provided by the U.S.S.R. have been greatly inferior to those provided by Japan. From 1959 (when the Soviets began commercial operations off Alaska) until 1964, no statistics were provided on catches except what can be inferred from scientific reports published on a few species. In 1964, the U.S.S.R. began providing the Food and Agriculture Organization (FAO) of the United Nations with figures on the catches of certain species in the eastern North Pacific. However, the catch area identified by the Soviets essentially included all fishing grounds in the eastern North Pacific between northern California (lat 40°30′ N) and Cape Prince of Wales,

Alaska (lat 65° N), and offshore to long 175°00′ W—which in the north intercepts the Chukchi Peninsula of the Soviet Union at East Cape, just south of the Arctic Circle (FAO Statistical Area 67). Catches for such a huge area are of extremely limited value in assessing the impact of fishing on individual stocks of fish and shellfish which typically inhabit much smaller areas and is in stark contrast to the detailed statistics on catches which were published or otherwise made available by the United States, Canada, and Japan for those years.

As a result of a bilateral fisheries agreement concluded between the United States and the U.S.S.R., statistics on the fisheries of the two nations in the eastern North Pacific were exchanged, beginning in 1967. However, for most of the period since 1967 the data provided by the Soviets has lacked detail on the area of capture and on the species harvested. The practice, until recently, was to provide data on catches of only a few primary target species and to combine the catches of all remaining species in a "miscellaneous" or "other species" category. On a few occasions this had led to the anomalous situation whereby the reported catch of miscellaneous or other species approached or even exceeded the reported catches of some of the target species.

As regards other nations fishing for bottomfish in the Bering Sea-Aleutian Island region, Poland has provided detailed statistics on the very limited operations by its vessels there. South Korea carried out a fairly large fishery for bottomfish but to date has not provided the U.S. with any useful statistics. Operations by Taiwanese vessels have been few and no statistics have been provided to the U.S.

### 3.0 Status of Stocks:

#### A. General Distribution and Abundance

The species of traditional importance to the region's trawl fisheries are listed in Table 8; their relative abundance can be inferred from the magnitude of recent catches. Prior to the mid-1960's, yellowfin sole and Pacific ocean perch were the primary target species; since then, walleye pollock has been by far the dominant element in the fishery. Except for salmon, a few hundred tons of Pacific halibut, and a small Eskimo fishery for spawning Pacific herring, the region's finfishes are taken exclusively by foreign fishermen.

Since walleye pollock has become the preeminent target of the region's fishery, other species have provided little more than by-catches. Exceptions include a distinct winter flounder fishery in the southeastern part of the region, a herring trawl and gillnet fishery in the north central Bering Sea, and a relatively small fishery for Pacific ocean perch along the Aleutian Island chain.

Little is currently known of the population structure of most of the species in this region but intense resource assessment research now underway should soon begin to identify individual stocks and complement the available fishery data which bear on stock condition.

TABLE 8.—*Ground fish catches (approximate) from the Bering Sea and Aleutian region, 1967–75*

[In Thousands of metric tons]

| Species and country | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|
| Halibut: | | | | | | | | | |
| United States and Canada | 1 | 1 | 1 | 1 | 1 | 1 | Tr. | Tr. | (?) |
| Japan | 4 | 3 | 3 | 3 | 5 | 1 | 1 | Tr. | (?) |
| U.S.S.R. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. |
| ROK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 6 | 4 | 4 | 3 | 6 | 2 | 1 | 1 | (?) |
| Rockfishes: | | | | | | | | | |
| United States | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | 31 | 50 | 32 | 25 | 25 | 15 | 13 | 30 | (?) |
| U.S.S.R. | 47 | 30 | 23 | 53 | 7 | 25 | 4 | 33 | 10 |
| ROK | 0 | 0 | 0 | 0 | 0 | Tr. | 0 | (*) | (?) |
| Total | 78 | 80 | 55 | 78 | 32 | 39 | 16 | 63 | (?) |
| Pollock: | | | | | | | | | |
| United States | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | 583 | 704 | 833 | 1,222 | 1,615 | 1,617 | 1,472 | 1,253 | (?) |
| U.S.S.R. | (*) | (*) | 34 | 45 | 220 | 215 | 290 | 381 | 220 |
| ROK | Tr. | 1 | 11 | 5 | 10 | 9 | 7 | 26 | (?) |
| Total | 583 | 705 | 878 | 1,281 | 1,761 | 1,841 | 1,769 | 1,660 | (?) |
| Flounders: | | | | | | | | | |
| United States | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | 94 | 64 | 110 | 110 | 140 | 120 | 147 | 178 | (?) |
| U.S.S.R. | 123 | 72 | 120 | 115 | 142 | 81 | 21 | 39 | 50 |
| ROK | 0 | Tr. | 0 | 0 | 0 | 0 | 0 | (*) | (?) |
| Total | 217 | 136 | 227 | 225 | 281 | 191 | 168 | 216 | (?) |
| Sablefish: | | | | | | | | | |
| United States | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | 13 | 13 | 14 | 10 | 15 | 14 | 7 | 7 | (?) |
| U.S.S.R. | Tr. | 4 | 2 | 3 | 1 | 2 | 1 | Tr. | Tr. |
| ROK | 0 | 0 | 0 | 0 | 0 | Tr. | (*) | (*) | (?) |
| Total | 13 | 14 | 16 | 13 | 16 | 16 | 9 | 7 | (?) |
| Cod: | | | | | | | | | |
| United States | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | (*) | (*) | (*) | (*) | (*) | (*) | 41 | 48 | (?) |
| U.S.S.R. | (*) | (*) | (*) | (*) | 4 | 7 | 13 | 17 | 24 |
| ROK | 0 | Tr. | 0 | 0 | 0 | 0 | 0 | (*) | (?) |
| Total | (?) | (?) | (?) | (?) | (?) | (?) | 54 | 64 | (?) |
| Herring: | | | | | | | | | |
| United States | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. | Tr. |
| Japan | 1 | 29 | 35 | 28 | 28 | 6 | 2 | 6 | (?) |
| U.S.S.R. | 0 | 22 | 94 | 117 | 28 | 54 | 54 | 20 | 10 |
| ROK | 0 | Tr. | 0 | 0 | 0 | 0 | Tr. | Tr. | (?) |
| Total | 3 | 51 | 129 | 145 | 56 | 60 | 57 | 26 | (?) |
| Others: | | | | | | | | | |
| United States | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Japan | 33 | 61 | 57 | 51 | 73 | 72 | 43 | 58 | (?) |
| U.S.S.R. | 8 | 28 | 7 | 16 | 4 | 102 | 19 | 16 | 25 |
| ROK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | (?) |
| Total | 42 | 89 | 64 | 66 | 77 | 174 | 62 | 82 | (?) |

#### B. Current Status

Fishery data indicate that the groundfish resources of this region have suffered the effects of almost 20 years of purse fishing in which one after another of the most abundant species was fished down to the point where catch rates became uneconomical. This led to another species becoming the target. The succession was: yellowfish sole; Pacific ocean perch; and now walleye pollock. As exploitation centered around each new species, bycatches of previous target species prevented their recovery. This phenomenon occurred on an inter-regional basis for shrimp and herring: shrimp stocks of the eastern Bering Sea were fished to commercial extinction in the early 1960's then effort shifted to the western Bering Sea where a similar trend is now occurring; herring in the western Bering Sea were quickly depleted in the mid-1960's—then effort shifted to the eastern Bering Sea where the stocks now appear to be deteriorating.

Specific comments concerning the major groundfish resources of the region follow.

(1) *Walleye Pollock*—(a) *Distribution.* Walleye pollock are broadly distributed in shelf and upper slope waters (to 450 m) from the southern coast of Korea northward into the Bering Sea and off the North American coast southward as far as California. In North American waters it is most abundant in the eastern Bering Sea.

Pollock in the eastern Bering Sea occur in waters south of a line joining Cape Navarin and St. Matthews Island (Serobaba, 1970). As in the case with many boreal species, pollock have seasonal migrations (Figure 7).

The main wintering grounds for adult pollock lie north of Unimak Island along the outer shelf and upper slope (150–280 m) (Serobaba, 1967; Maeda, 1972) where bottom temperatures range from 2.5°–4.5° C, with greatest concentrations

in the 2°–4° C isotherm (Serobaba, 1970). As the water column warms in spring, pollock migrate to shallower water and spawn in depths of 50–300 m from March to the middle of July with the height of spawning in May (Serobaba, 1967). At that time surface water temperatures range between 1.4 and 3.3° C and bottom temperatures from below 0° C to 3.4° C. During this migration, larger fish mix with the smaller ones in shallow waters. When spawning begins, however, the sexually mature pollock generally separate from the nonspawning portion of the population (Maeda, 1972).

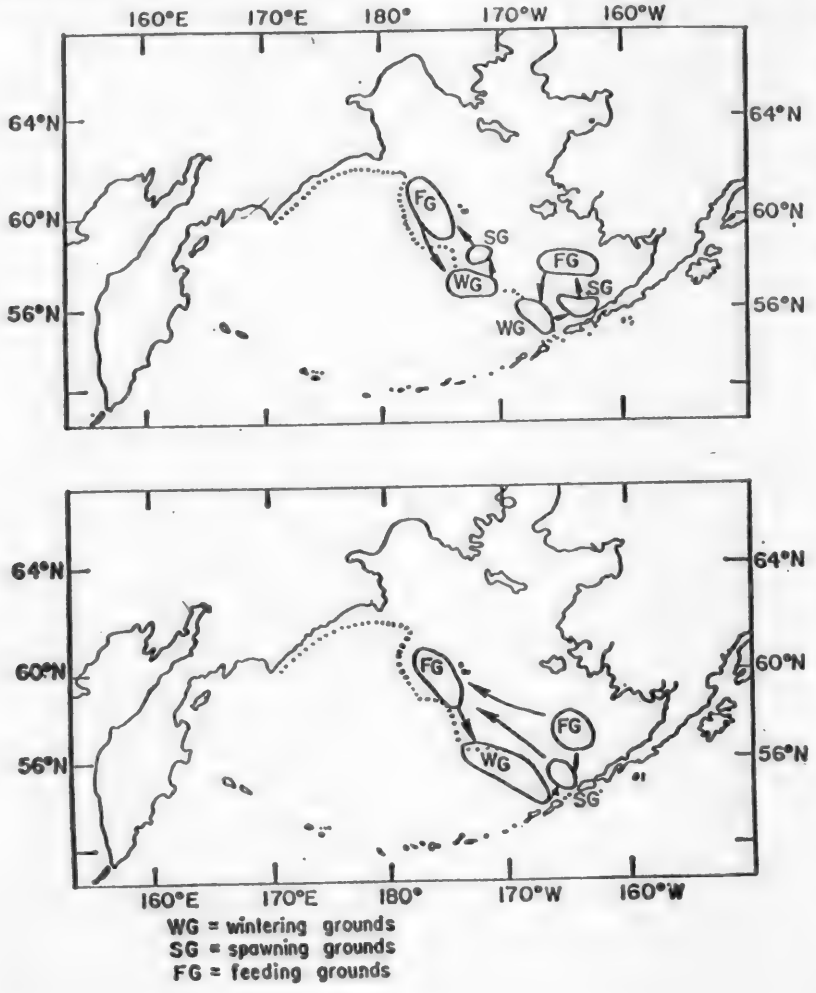


Figure 7. Schematic diagram showing the concept of one and two stocks of pollock in the eastern Bering Sea (Maeda, 1972).

In summer and autumn pollock are distributed on the inner and outer shelf of outer Bristol Bay and northwest of the Pribilof Islands. With the onset of winter, the pollock move back across the shelf to deeper water for overwintering (Figure 7).

The eastern Bering Sea pollock resource is considered by some scientists (National Marine Fisheries Service, 1974; Maeda, 1972) to be composed of two stocks. Catch patterns suggest that these two stocks are separated at about 170° W longitude. The southeastern stock is the larger of the two and has over the years contributed much more to the fishery.

Clear cut evidence is lacking to verify that these two stocks are in fact discrete because of different population reactions to environmental stresses (Ishida, 1967). Consequently, for practical purposes, analyses related to the appraisal of stock conditions assume the eastern Bering Sea pollock resource to be a single stock (Chang, 1974; Low, 1974, Takahashi, 1975).

(b) *Abundance.* Walleye pollock supports the largest single species fishery in the North Pacific; in recent years, this fishery has been second only to that for anchoveta (*Cetengraulis mysticetus*) off Peru. From 1970 through 1974 the annual catch of pollock in the Bering Sea and Aleutian Island area has exceeded 1 million mt with a maximum of about 1.9 million mt in 1972 (Table 9). During those years, Pollock constituted from 68 to 83 percent of the total fin-fish landings from the eastern Bering Sea.

TABLE 9.—*Annual catch of walleye pollock in the eastern Bering Sea, 1964–73 (in metric tons)*

| Year | Nation | | | Total |
|---|---|---|---|---|
| | Japan [1] | U.S.S.R.[2] | ROK [3] | |
| 1964 | 174,792 | ---------- | ---------- | 174,792 |
| 1965 | 230,551 | ---------- | ---------- | 230,551 |
| 1966 | 261,678 | ---------- | ---------- | 261,678 |
| 1967 | 550,362 | ---------- | ---------- | 550,362 |
| 1968 | 700,981 | ---------- | 1,200 | 702,181 |
| 1969 | 830,494 | 27,295 | 5,000 | 862,789 |
| 1970 | 1,231,145 | 20,420 | 5,000 | 1,256,565 |
| 1971 | 1,513,293 | 219,640 | 10,000 | 1,743,763 |
| 1972 | 1,651,438 | 213,896 | 9,200 | 1,874,534 |
| 1973 | 1,475,114 | 280,005 | 3,100 | 1,758,219 |
| 1974 [4] | 1,193,073 | 309,613 | 26,000 | 1,528,686 |

[1] From Japan fisheries agency.
[2] U.S.S.R. trawl fishery east of 180° longitude in the Bering Sea.
[3] Estimates based on U.S. surveillance of ROK fishing activities.
[4] January to October figure (provisional data).

Both absolute and relative abundance have been estimated for the exploitable portion of the eastern Bering Sea pollock population. Using the area-swept method, Chang (1974) and Low (1974) estimated the exploitable biomass of pollock in the eastern Bering Sea in 1969 and 1970 to be in excess of 2.5 million mt. In another procedure using cohort analysis, Chang (1974) estimated the standing stock of pollock older than ages 2–3 to be at least 2.4 million mt or about 8.4 billion fish.

(c) *Maximum sustainable yield.* Estimates of maximum sustainable yield (MSY) for pollock have been obtained by two methods: the surplus production

model method of Pella and Tomlinson (1969) and the method of Alverson and Pereyra (1969) for the first approximation of yield per exploitable biomass.

Estimates thus derived range from 1.11 million mt to 1.59 million mt (Low, 1974).

Inasmuch as MSY pertains to the average, long-term situation, it has limited utility as a basis for determining the allowable harvest of such a short-lived species as pollock for any given year.

Although this species may live as long as 12 years, throughout the history of the fishery comparatively few fish older than 6 years have been taken, with the dominant age classes being 3–6 years. Without the buffering effect of an accumulation of year classes distributed over a wide range of age classes, the productivity of such a stock can be expected to respond very rapidly to variations in recruitment caused by changing environment. Therefore, year-to-year management of the fishery must consider other biological indicators relevant to the stock in its current rather than past state.

For instance, the fishery could be managed in such a manner that the harvest does not exceed the recruitment into the population.

Takahashi (1975) has estimated the annual recruitment to the eastern Bering Sea population by age groups and in numbers and weight for the period 1968 to 1973 (Table 10) and found that annual recruitment ranged from 1 to 2 million mt. There are, however, practical problems associated with obtaining *in advance* accurate estimates of annual recruitment.

(d) *Status.* Certain evidence indicates that the pollock stock of the eastern Bering Sea has in recent years been overfished: catches in 1971–74 exceeded the upper limit of the MSY range; catches in 1973 and 1974 exceeded Takahashi's estimates of recruitment for those years; the overall CPUE for Japanese pair trawlers in 1973 and 1974 was only one-third that of 1969; catch rates were sustained at rather high levels for about 4 years by shifts in the areal allocation of effort; however, since 1970, CPUE has been at comparatively low levels in all areas of the eastern Bering Sea. Similar trends have been noted in overall CPUE values (Figure 8).

Condition of the pollock stock may be more unfavorable than is apparent from these trends in CPUE, in that the fishery has substantially altered the abundance of the age groups in the population. The average size of pollock in the Japanese catch has declined from over 44 cm in 1965 to about 32.2 cm in 1975 Table 11). This decline has resulted in the fishery now being heavily dependent upon pollock of younger age groups which were not exploited in the earlier years. In the past, catches were composed primarily of fish 3 through 5 years of age; in 1974, the 2-year-old age class was second in abundance in the Japanese catch and 1-year-old fish first appeared in measurable quantities (Figure 9).

TABLE 10.—*Estimated annual recruitment (in weight, metric ton) of pollock in the eastern Bering Sea, 1965–74. The method used was shown in the appendix of document 1699 and the parameters used were as follows: Natural mortality coefficient $M=0.429$; Catchability coefficient $q=7.080\times10^{-6}$, Dispersion coefficient (older than 6) $B=0.343$*

| Year | Age | | | | | | | | | | | Total recruitment | Total catch |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | |
| 1965 | 420 | 78,153 | 686,714 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 765,287 | 225,908 |
| 1966 | 2,800 | 131,665 | 293,763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 428,228 | 301,788 |
| 1967 | 193 | 186,579 | 715,569 | 85,009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 984,210 | 345,853 |
| 1968 | 5,297 | 217,799 | 944,191 | 180,263 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,347,489 | 494,352 |
| 1969 | 631 | 167,469 | 952,302 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,120,404 | 623,895 |
| 1970 | 3,286 | 435,555 | 1,002,647 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,433,488 | 1,200,168 |
| 1971 | 21,272 | 306,938 | 683,059 | 33,538 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,094,908 | 1,489,770 |
| 1972 | 39,940 | 498,837 | 855,159 | 616,824 | 90,885 | 28,396 | 7,715 | 1,287 | 149 | 21 | 6 | 2,140,305 | 1,663,483 |
| 1973 | 33,520 | 537,370 | 724,409 | 197,512 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,492,944 | 1,485,040 |
| 1974 | 122,851 | 438,462 | 448,686 | 131,838 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,141,830 | 1,263,848 |

SOURCE: Takahashi, 1975.

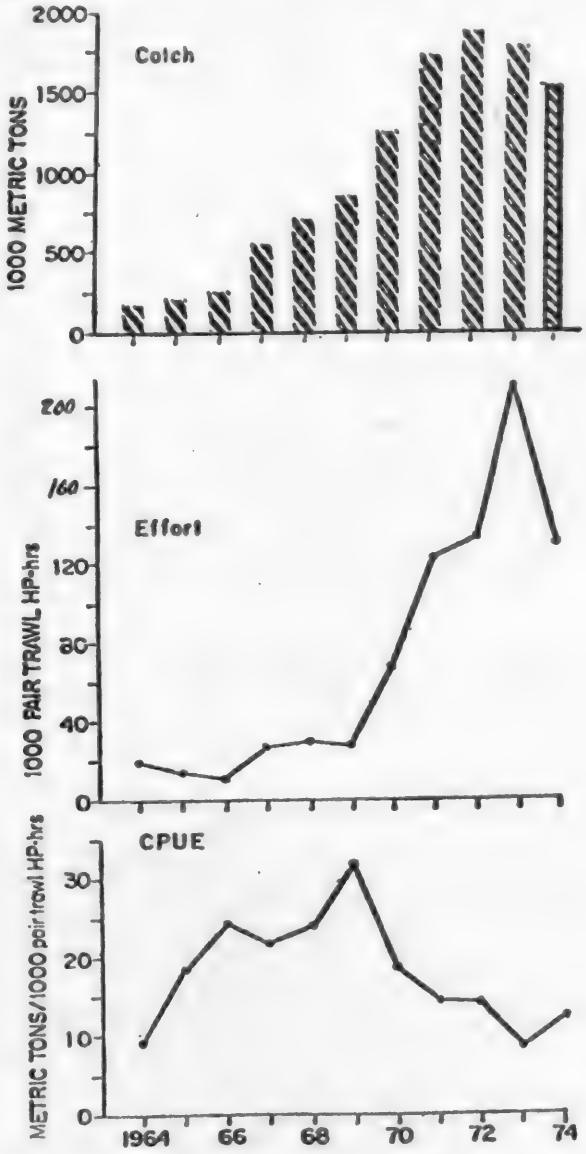


Figure 8.--Annual catch of pollock by all nations in the eastern Bering Sea and estimated effective effort and CPUE, 1964-1974

TABLE 11.—*Average body length of pollock taken in the Japanese eastern Bering Sea pollock fisheries (1964–75)*

| Year | Average length (centimeters) | |
|---|---|---|
| | Japan fishery agency [1] | U.S. observers [2] |
| 1964 | 42.7 | |
| 1965 | 44.3 | |
| 1966 | 42.8 | |
| 1967 | 43.2 | |
| 1968 | 42.7 | |
| 1969 | 42.8 | |
| 1970 | 40.8 | |
| 1971 | 40.3 | |
| 1972 | 39.8 | |
| 1973 | 37.7 | 36.2 |
| 1974 | 35.3 | 35.0 |
| 1975 | | [3] 32.2 |

[1] Mean size based on size and catch data provided by the fisheries agency of Japan through INPFC.
[2] Mean size based on catch data from fisheries agency of Japan and size data collected by U.S. observers aboard Japanese vessels.
[3] Mean size based on U.S. observer size data weighted by catch data from fisheries agency of Japan for January to July 1975 (INPFC document 1804), and catch data from fisheries agency of Japan for August to December 1974, by INPFC halibut conservation area and type of fisheries (Mothership Fishery and North Pacific Trawl Fishery).

Pollock attain sexual maturity at about 3 years of age or about 30 cm in length (Ishida, 1967; Serobaba, 1967). Chang (1974) noted that yield is maximized when pollock are recruited into the fishery at ages 3–4, which corresponds to 38–40 cm in length. Considering that pollock first spawn at about 30 cm or 3 years of age, the fishery is obviously exploiting substantial numbers of prespawners which, if excessive, would have unfavorable effects on the productivity of the stock.

The reduction in average size of pollock in the catch can also be interpreted as being indicative of the entry of very strong year classes into the population. Results of research vessel surveys, however, show that the relative abundance of 2 and 3 year old pollock has been declining in recent years.

Considering (1) that there has been a steady decline in CPUE throughout the entire eastern Bering Sea, (2) that the CPUE of mature pollock has been severely reduced in abundance with substantial increases in the catch of pollock of pre-spawning sizes, and (3) that the abundance of incoming year classes appears to have been dropping, there is reason to believe that the condition of the eastern Bering Sea pollock resource has been deteriorating in recent years.

(e) *Estimated equilibrium yield.* Knowledge of the eastern Bering Sea pollock stock condition is not exact enough to provide absolute values of recruitment and sustainable yield. Recent catches have been far in excess of MSY, and have forced the stock into a condition that will not allow MSY to be achieved. Therefore, equilibrium yield, under current conditions, would be substantially below MSY, perhaps near 1 million mt. An even lower catch would be required to allow the stock to rebuild, over a 1–3 year period, to a level that could produce MSY.

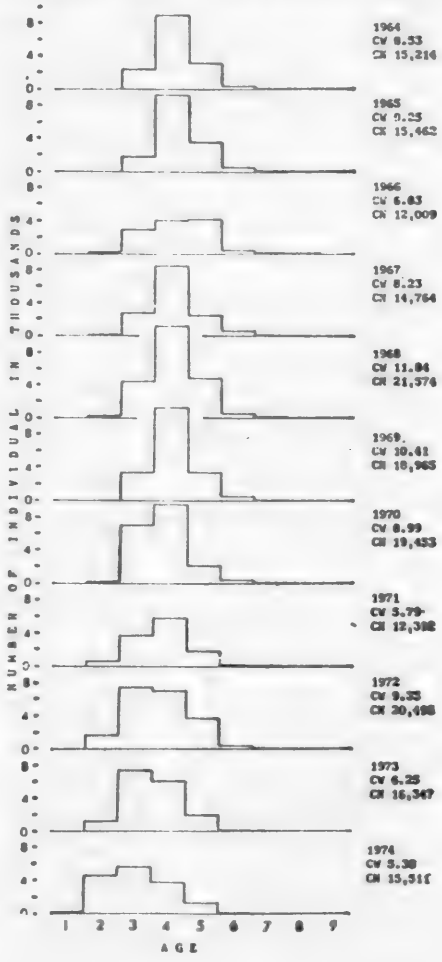


Figure 9.--Age composition of pollock samples collected from the Japanese trawl fishery in the eastern Bering Sea (CW = sample size in metric tons; CN = sample size in numbers of individuals).

(2) *Yellowfin Sole.*—(a) *Distribution.* Yellowfin sole are broadly distributed over the upper slope and shelf of the eastern Bering Sea with concentrations of commercial quantities confined to waters south of 60° N latitude. Evidence from Soviet resource surveys (Fadeev 1970) and the seasonal changes in fishing grounds (Wakabayashi 1974) indicate that the bathymetric distribution of yellowfin sole varies with season. During winter the species inhabits the outer shelf and upper slope (100–270 m), but with the onset of spring it migrates to shallower waters where spawning occurs during summer and early autumn on the inner shelf (<100 m).

Recent evidence from tagging indicates that there may be two yellowfin sole stocks separated by a line connecting St. George Island (about 58°58′ N, 164°14′ W) and Cape Avinof (about 59°58′ N, 164°14′ W). (Figure 10.) The stock inhabiting the southern area is by far the larger as evidenced by the fact that between 1964 and 1974, more than 80% of the Japanese catch was taken from there. Although the results of U.S. research surveys do not conclusively confirm the discreteness of the two stocks, they do show that the greatest proportion of the total eastern Bering Sea yellowfin sole population is in the southern area.

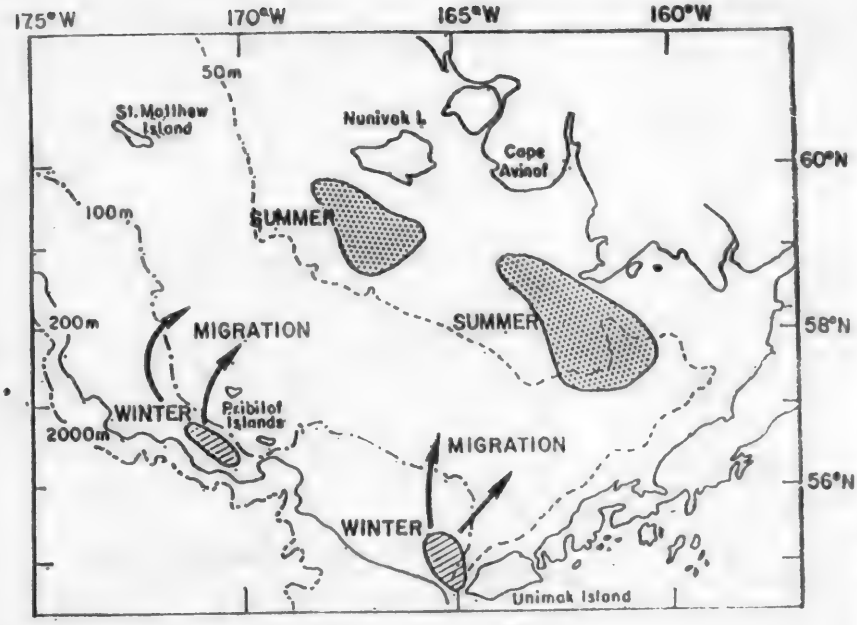


Figure 10.--Schematic diagram showing location of winter and summer concentrations of two yellowfin sole stocks in the eastern Bering Sea.

According to Fadeev (1970) the maximum age of yellowfin sole in the eastern Bering Sea is 19 years, at which a length of about 46 cm is attained. Wakabayashi (1974) reported the occurrence in Japanese catches of 20 year old fish and showed that the size at first spawning is 10.5 cm for males (2–3 yrs) and 18.5 cm (5–6 yrs) for females. The size at which 50% of the fish become mature is 13 cm (3–4 yrs) for males and 26 cm (8–10 yrs) for females. These fish are first recruited to the fishery at 4 years of age and are fully recruited at age 6, slightly before the age at which 50% reach maturity. In the early years of the fishery, individuals as old as 15 years were well represented in the landings but the accumulation of older age groups has been substantially reduced and the bulk of the catch in recent years has been composed of fish 12 years of age or younger.

(b) *Abundance.* Yellowfin sole are the most abundant of the flatfish in the eastern Bering Sea, constituting 73–85% of the total Soviet research vessel flatfish catches (Fadeev 1970).

Relative abundance of the yellowfin sole population has been evaluated by examination of catch per unit of effort (CPUE) of the Japanese trawl fisheries. Attempts have also been made to estimate the stock size of this population in terms of absolute biomass. To put the results of either procedure into perspective and to properly evaluate the current status of the stock requires a recapitulation of some historical events in the yellowfin flounder fishery.

Prior to the mid-1960's, the yellowfin sole was the principal target species of the eastern Bering Sea trawl fisheries. From 1954 through 1957, the Japanese were the only users of this resource with annual catches of less than 25,000 mt. In 1958 the Soviet fleet entered the fishery and the combined Japanese and Soviet catch increased to about 44,000 mt. The total catch increased substantially in 1959 to 185,000 mt, 493,000 mt in 1960, and peaked at about 610,000 mt in 1961. Production then fill off sharply to about 393,000 mt in 1962, fluctuated between 62,000 to 207,000 mt during 1963–1971, and has remained well below 100,000 mt since 1971 (Table 12).

TABLE 12.—*Annual catches of yellowfin sole[2] in the eastern Bering Sea (east of 180°) in metric tons*

| Year | Japan [1] | U.S.S.R.[2] | Total |
|---|---|---|---|
| 1954 | 12,562 | ---- | 12,562 |
| 1955 | 14,690 | ---- | 14,690 |
| 1956 | 24,697 | ---- | 24,697 |
| 1957 | 24,145 | ---- | 24,145 |
| 1958 | 39,153 | 5,000 | 44,153 |
| 1959 | 123,121 | 62,200 | 185,321 |
| 1960 | 396,946 | 96,000 | 492,946 |
| 1961 | 455,885 | 154,200 | 610,085 |
| 1962 | 253,420 | 139,480 | 392,900 |
| 1963 | 21,576 | 92,596 | 114,172 |
| 1964 | 48,928 | 81,872 | 130,800 |
| 1965 | 26,030 | 36,170 | 62,200 |
| 1966 | 45,105 | 71,295 | 116,400 |
| 1967 | 58,415 | 120,000 | 178,415 |
| 1968 | 29,646 | 57,092 | 86,738 |
| 1969 | 81,448 | 103,850 | 185,298 |
| 1970 | 59,780 | 106,875 | 166,655 |
| 1971 | 82,205 | 124,441 | 206,646 |
| 1972 | 34,845 | 36,738 | 71,583 |
| 1973 | 75,514 | 4,497 | 80,011 |
| 1974 | 38,270 | 9,200 | 47,470 |
| 1975 | [3] 20,594 | 49,800 | 70,394 |

[1] Catches by Japanese mother ship and North Pacific trawl fisheries. Catches for 1954 to 1963 are from Forrester et al. (1974) and for 1964 to 1975 from data provided to the United States by Japan. Includes catches of some other flounders up to 1961.

[2] U.S.S.R. catches from 1958 to 1961 from Fadeev (1970), for 1962 to 1966 from document 1669 and for 1967 to 1975 from data provided the United States by the Soviet Union. Soviet data includes catches of some other flounders. Catches for 1970 and 1971 differ from those in INPFC document 1785 due to the transfer of some flounders from the other fish category.

[3] January through July only.

Although catches during the mid and late 1960's were much smaller than those of the peak years of production, they were too high to allow any sustained recovery of the resource and the stock remained in a depressed condition into the early 1970's (Bakkala and Hirschhorn, 1975; Wakabayashi, 1975; International North Pacific Fisheries Commission, 1975) (Table 13; Figure 11).

Wakabayashi (1974) estimated the stock of yellowfin sole 6 years old and older to be 1.3 million mt in 1955. Stock size increased to about 2 million mt in 1958-60 but declined to under 1 million mt during 1962–70. Low (1974) considers the stock to have passed through five phases of abundance: in the near virgin state of 1954–61, biomass was estimated to be about 600,000–1,000,000 mt; this was followed in 1961–64 by a rapid depletion phase to about 390,000 mt in 1964; the stock was in a depressed phase during 1964–69 when biomass varied between 250,000–390,000 mt; during 1969–71 biomass increased moderately to about 470,000 mt; during 1971–73 biomass again declined then stabilized at a level somewhat less than 300,000 mt.

Information from trawl surveys in 1975–76 (expanded by the area-swept technique) by the National Marine Fisheries Service indicates that the exploitable biomass of yellowfin sole (ages older than 6) has increased substantially to 865,000 mt (95 percent C.I. ≈ 725,000–1,005,000 mt).

TABLE 13.—*Catch of yellowfin sole, fishing effort, and CPUE for the Japanese trawl fisheries in the southeastern stock area of the eastern Bering Sea, 1964 to 1973. Data are for 1°×½° statistical blocks and months in which yellowfin sole made up 50 pct or more of the catch of groundfish*

| Season | Gear | Year | Catch (metric tons) | Effort | | | CPUE in metric tons per 1,000 hph or hp-sets |
|---|---|---|---|---|---|---|---|
| | | | | Number of hours or sets | Average horsepower [1] | Horsepower-hours or horsepower-sets (in thousands) | |
| Spring-summer (April to September) | Pair trawl | 1964 | 15,760 | 2,275 | 325 | 739 | 21.33 |
| | | 1965 | 6,108 | 708 | 328 | 252 | 24.24 |
| | | 1966 | 3,333 | 909 | 315 | 286 | 11.65 |
| | | 1967 | 895 | 210 | 280 | 59 | 11.19 |
| | | 1968 | 0 | 0 | ---- | ---- | ---- |
| | | 1969 | 1,167 | 174 | 454 | 79 | 14.77 |
| | Danish seine | 1964 | 22,788 | 6,159 | 275 | 1,694 | 13.45 |
| | | 1965 | 5,890 | 2,346 | 333 | 781 | 7.54 |
| | | 1966 | 2,698 | 1,135 | 320 | 363 | 7.43 |
| | | 1967 | 567 | 338 | 393 | 133 | 4.26 |
| | | 1968 | 3,243 | 978 | 456 | 446 | 7.27 |
| | | 1969 | 2,950 | 1,168 | 509 | 595 | 4.96 |
| Winter (October to March) | Pair trawl | 1969–70 | 14,250 | 1,925 | 1,200 | 2,310 | 6.17 |
| | | 1970–71 | 26,766 | 1,762 | 1,200 | 2,114 | 12.66 |
| | | 1971–72 | 25,812 | 2,929 | 1,400 | 4,101 | 6.29 |
| | | 1972–73 | 31,328 | 2,700 | 1,400 | 3,780 | 8.29 |
| | | 1973–74 | 27,234 | 1,853 | 1,400 | 2,594 | 10.50 |
| | Stern trawl | 1969–70 | 6,594 | 1,999 | 1,650 | 3,298 | 2.00 |
| | | 1970–71 | 2,521 | 1,112 | 1,400 | 1,557 | 1.62 |
| | | 1971–72 | 8,587 | 2,282 | 1,325 | 2,997 | 2.87 |
| | | 1972–73 | 11,596 | 5,890 | 1,400 | 8,246 | 1.41 |
| | | 1973–74 | 3,990 | 3,708 | 1,400 | 4,575 | 0.87 |

[1] Measures of average horsepower of pair trawlers and Danish seiners for 1964 to 1969 are from Takahashi (1974). Those for 1969–70 to 1973–74 are from Takahashi (personal communications, Takahashi, Y., Japan Fishery Agency Far Sea Fisheries Research Laboratory, Shimizu, Japan, March 1976. Source: Bakkala and Hirschhorn (1976)).

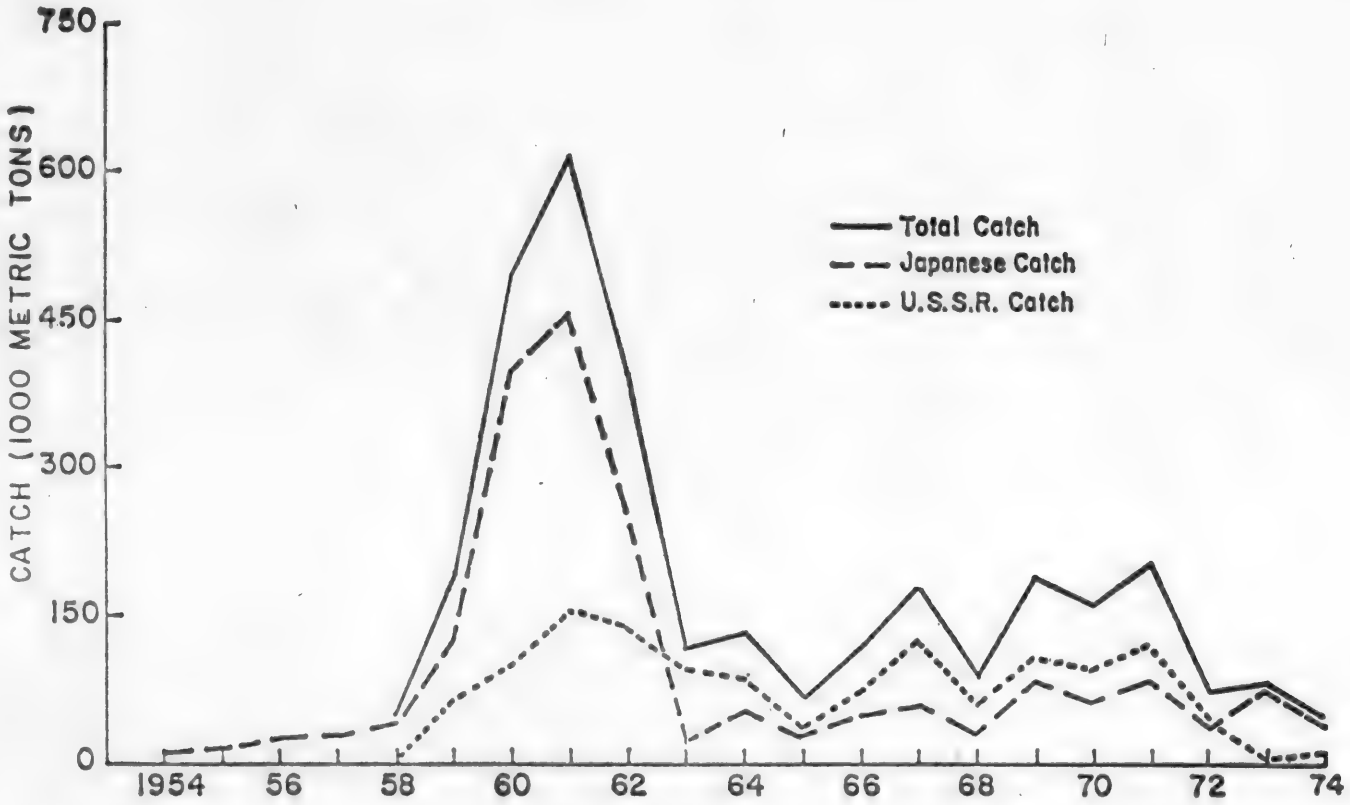


Figure 11.--Catches of yellowfin sole in the Bering Sea east of $180^0$ by Japan and the Soviet Union

(c.) *Maximum sustainable yield.* Fadeev (1970) estimated natural mortality (M) of yellowfin sole to be 0.26. Using Wakabayashi's estimates of exploitable biomass for the period before the effects of heavy exploitation would have greatly depressed the virgin population (1.3–2.0 million mt) and applying Alverson and Pereyra's (1969) equation for a first approximation of "yield per exploitable biomass"[1] gives a potential yield range of 152,000–270,000 mt. Similar calculations using Low's (1974) estimate of near-virgin biomass (60,000–1,000,000 mt) results in an MSY range of 70,000–117,000 mt.

(d.) *Status.* After a short period of intense overexploitation and a decade of removals which, although much lower than during the peak years, were sufficient to prevent rebuilding—recent survey results indicate a substantial increase in the biomass of fish older than 4 years. Whether or not the stock can now be considered "healthy" or completely rebuilt, it does appear to be in much better condition than at any time during the last 15 years.

(e.) *Equilibrium yield.* On the basis of Wakabayashi's (1975) vitual population analysis, an exploitation rate of 0.146 applied to fish older than age 6 results in equilibrium yield.

Applying this exploitation rate to the current standing stock of yellowfin sole older than age 6 (725,000–1,005,00 mt; p. 69) provides an estimated current equilibrium yield of 106,000–147,000 mt.

(3) *Other Flounders.*—Flounders, primarily yellowfin sole, were the incentive for both Japanese and Soviet fishing in the eastern Bering Sea. Flatfishes other than yellowfin sole and Pacific halibut are now, for the most part, caught incidentally to the expanded pollock fishery. The most important of these species, in order of relative abundance, are arrowtooth flounder, flathead sole, and rock sole. The status of these resources is difficult to evaluate because of their secondary importance in the fishery.

(a) *Turbot.* The term "turbot" generally includes both arrowtooth flounder and Greenland turbot. Turbot are concentrated mainly on the continental slope and therefore inhabit deeper waters than yellowfin sole, flathead, and rock sole.

The peak catch of turbot was 63,300 mt in 1964; average catch over the next 7 years was about 27,800 mt (Table 14). In 1972, the catch increased to 56,000 mt —the second highest on record—then dropped to 46,100 mt in 1974.

Because it is taken only incidentally to fisheries for other species, the status of turbot stocks is difficult to assess with standard data bases and analyses. Inasmuch as peak catches of 63,300 mt (in 1964) and 56,900 mt in 1972) apparently could not be sustained, MSY and equilibrium yield appear to be near the 1973–74 catch level of 40,000 mt (Low, 1976).

TABLE 14.—*Flathead sole, rock sole, and turbot catch by nation in the Bering Sea in metric tons, 1965–74*

| Year | Japan | | U.S.S.R.[3] | Total |
|---|---|---|---|---|
| | MS–LG–NPT[1] | LBD[2] | | |
| **(A) FLATHEAD SOLE** | | | | |
| 1964 | 12,301 | 0 | 10,285 | 22,586 |
| 1965 | 3,229 | 102 | 2,626 | 5,957 |
| 1966 | 4,802 | 250 | 5,099 | 10,160 |
| 1967 | 10,539 | 525 | 13,840 | 24,902 |
| 1968 | 11,101 | 1,465 | 12,896 | 25,462 |
| 1969 | 8,620 | 1,112 | 10,584 | 20,316 |
| 1970 | 18,377 | 2,594 | 19,969 | 40,940 |
| 1971 | 24,925 | 1,270 | 23,929 | 50,124 |
| 1972 | 9,427 | 993 | 4,630 | 15,050 |
| 1973 | 16,623 | 756 | 8,602 | 25,981 |
| 1974 | 12,763 | 442 | 14,553 | 27,758 |
| **(B) ROCK SOLE** | | | | |
| 1964 | 2,773 | 0 | 2,319 | 5,092 |
| 1965 | 1,588 | 0 | 1,291 | 2,879 |
| 1966 | 4,414 | 0 | 4,687 | 9,101 |
| 1967 | 1,990 | 149 | 2,613 | 4,752 |
| 1968 | 2,352 | 327 | 2,732 | 5,411 |
| 1969 | 3,988 | 877 | 4,897 | 9,762 |
| 1970 | 9,674 | 806 | 10,510 | 20,990 |
| 1971 | 19,311 | 1,789 | 18,539 | 39,639 |
| 1972 | 44,269 | 1,540 | 21,741 | 67,550 |
| 1973 | 22,732 | 1,785 | 11,763 | 36,281 |
| 1974 | 17,214 | 752 | 19,629 | 37,595 |
| **(C) TURBOT** | | | | |
| 1964 | 34,475 | 0 | 28,826 | 63,301 |
| 1965 | 7,562 | 309 | 6,165 | 14,056 |
| 1966 | 10,040 | 98 | 10,661 | 20,799 |
| 1967 | 20,032 | 356 | 26,307 | 46,695 |
| 1968 | 16,496 | 1,131 | 19,164 | 36,791 |
| 1969 | 13,414 | 1,136 | 16,471 | 31,021 |
| 1970 | 9,638 | 308 | 10,471 | 20,415 |
| 1971 | 6,417 | 12,576 | 6,160 | 25,153 |
| 1972 | 1,296 | 54,923 | 636 | 56,855 |
| 1973 | 1,570 | 31,909 | 812 | 34,191 |
| 1974 | 3,970 | 37,577 | 4,527 | 46,074 |

[1] Mothership, long-line gillnet, and North Pacific trawl, fisheries. Catch by fishing year (November of previous year to October of statistic year).
[2] Land-based dragnet fishery. Catch by calendar year.
[3] U.S.S.R. statistics for 1964–66 from FAO fisheries statistics (north from 20° N. and east of 170° W.); for 1967–1972 from Larkins (1974); for 1973 from International North Pacific Fisheries Commission, 1975; and for 1974 from United States-U.S.S.R. data exchange (east of 180°, north of 54°30' N.). Catch of flatfishes were broken down by the ratio of Japanese species composition and by calendar year.

SOURCE: International North Pacific Fisheries Commission, 1975.

(b) *Rock Sole.* Rock sole are found mainly on the eastern Bering Sea shelf where yellowfin sole predominate. However, the abundance of this species is considerably less than that of yellowfin sole as indicated by catch rates and is an incidental catch to the yellowfin sole fishery.

Catches of rock sole varied betweenn 2,900 mt in 1965 and 9,800 mt in 1968 (Table 14), increased to the historical peak of 67,000 mt in 1972, then decreased to 37,600 mt in 1974. These figures may not be accurate because of inconsistencies in the categorization in vessel catch records of rock sole as a separate species group.

Wolotira (1975) reported that catches during recent years have been maintained by the relatively strong year-classes of 1965 and 1966 and that thses cohorts had been diminished by several years of exploitation with no sign of subsequent strong year classes. Size composition data for 1974 do not indicate otherwise.

Based upon historical catch pattern and apparent lack of year-class strength in the stocks, MSY and equilibrium yield appear to be somewhat below the catch level of 1974, and perhaps 35,000 mt (Low 1976).

(c) *Flathead sole.* Flathead sole are found mainly on the eastern Bering Sea shelf, but on somewhat deeper grounds than occupied by yellowfin sole and rock sole. They are caught mainly as an incidental species in the yellowfin sole and pollock fisheries, so catch rates are not appropriate indicators of flathead sole abundance.

Catches of flathead sole have ranged from 6,000 mt in 1965 to 50,000 mt in 1971 (Table 14). From 1969 to 1971, the catch more than doubled (from 20,300 mt to 50,000 mt), declined to 15,000 mt in 1972, and increased again to 27,800 mt in 1974. These values, however, may not be very accurate because of inconsistencies in the categorization of flathead sole as a separate species by Japanese fisheries (Takahashi, 1975). The U.S.S.R., on the other hand, provides no breakdown of the species composition of its flounder catch; it is assumed to be similar to that of the Japanese fishery.

Weighted size composition data for flathead sole taken in the Japanese fisheries show that more small fish were taken in 1974 than in previous years. If there was neither selection for smaller fish nor a shift of the fishery to a different segment of the population, this information suggests either relatively good recruitment of young fish into the fishery or lower abundance of larger individuals.

On the basis of recent catch trends and the indication of recent strong recruitment, MSY and equilibruim yield appear to be slightly above the 1974 catch level, and near 30,000 (Low, 1976).

(4) Pacific Ocean Perch.—(a) *Distribution and abundance.* Pacific ocean perch is the most abundant rockfish species in the North Pacific. Chikuni (1975a) identified two main stocks in the Bering Sea: an Eastern Slope stock along the southern half of the eastern Bering Sea continental slope and an Aleutian stock along both sides of the Aleutian Islands. These stocks may mix at various stages of life history but variations in growth rate, length-weight, age-length, and length-fecundity relationships suggest distinct stocks. Ocean perch are concentrated mainly in the upper waters of the continental slope (at depths of 150–500 m). In the Bering Sea the larger concentrations are located in the region of Pribilof Islands and at the southeastern part of the continental slope (Pautov, 1972). In the Aleutian Region, the largest concentration occurs between 175° W–180°, especially on the north side of the island chain (Low, 1976).

Of the two main stocks in the Bering Sea, the Aleutian stock, is at present, perhaps four times larger than that of the Eastern Slope. Chikuni estimated that in 1972 its biomass was close to 150 thousand mt. By comparison, biomass of the Eastern Slope stock is probably close to 35 thousand mt. Biomass estimates have not been made for more recent years but based upon CPUE analyses, they would undoubtedly be below those for 1972.

Catches from each of the stocks are shown in Table 15.

TABLE 15.—*Pacific ocean pearch catches in the eastern Bering Sea and Aleutian, by regions in thousand metric tons, 1960–74*

| Year | Eastern slope | Aleutian | Total |
|---|---|---|---|
| 1960 | 6 | ---- | 6 |
| 1961 | 47 | ---- | 47 |
| 1962 | 20 | (1) | 20 |
| 1963 | 25 | 21 | 46 |
| 1964 | 26 | 92 | 118 |
| 1965 | 17 | 110 | 127 |
| 1966 | 20 | 90 | 110 |
| 1967 | 20 | 61 | 81 |
| 1968 | 32 | 51 | 83 |
| 1969 | 15 | 39 | 54 |
| 1970 | 10 | 67 | 77 |
| 1971 | 10 | 22 | 32 |
| 1972 | 6 | 34 | 40 |
| 1973 | 3 | 12 | 15 |
| 1974 [2] | 14 | 22 | 36 |

[1] Less than 1,000 metric tons.
[2] Data is preliminary.

SOURCE: International North Pacific Fisheries Commission (1975).

(b) *Status.* Based upon analyses by Chikuni (1975b) and Wolotira (1975a), the INPFC Sub-Committee on Bering Sea Groundfish concluded that it is "apparent that stock abundance in the Eastern Slope region decreased drastically in the latter half of the 1960's. Since then it remained relatively stable * * * but * * * stock abundance was low" (International North Pacific Fisheries Commission, 1975).

The spawning stock of ocean perch in the Eastern Slope region is considered to be considerably reduced from the level of the mid-1960's. Chikuni (1975b) showed that the early extensive ocean perch harvests by Japan and the U.S.S.R. had removed most of the larger, older, and more fecund [2] fish from the stock. Therefore, in recent years, larval production by the stock must have been considerably reduced. Whether or not reduced larval production will result in reduced recruitment, however, has not been determined.

Chikuni (1975a) also found that ocean perch are being recruited into the fishery 1–2 years younger than desired to achieve maximum yield per recruit. Since 1968, the fishery has been heavily dependent upon young fish from the strong year-classes of 1961 and 1962 (Chikuni, 1974b); because of recent, heavy removals of these young year-classes, their strength is not expected to prevail and no other strong ones have appeared.

With regard to the Aleutian stocks, CPUE (mt per hour trawled) for Japanese stern trawlers has dropped from 7.3 in 1964 to 0.9 in 1972 and 0.8 in 1974 (Figure 12). Although the catch in 1974 was twice that of 1972, fishing effort more than tripled—reaching the highest level in history. Consequently, the catch rate in 1974 was less than that observed in 1973 and, indeed, was the lowest on record. Similar trends have occurred in other elements of the Japanese fishery.

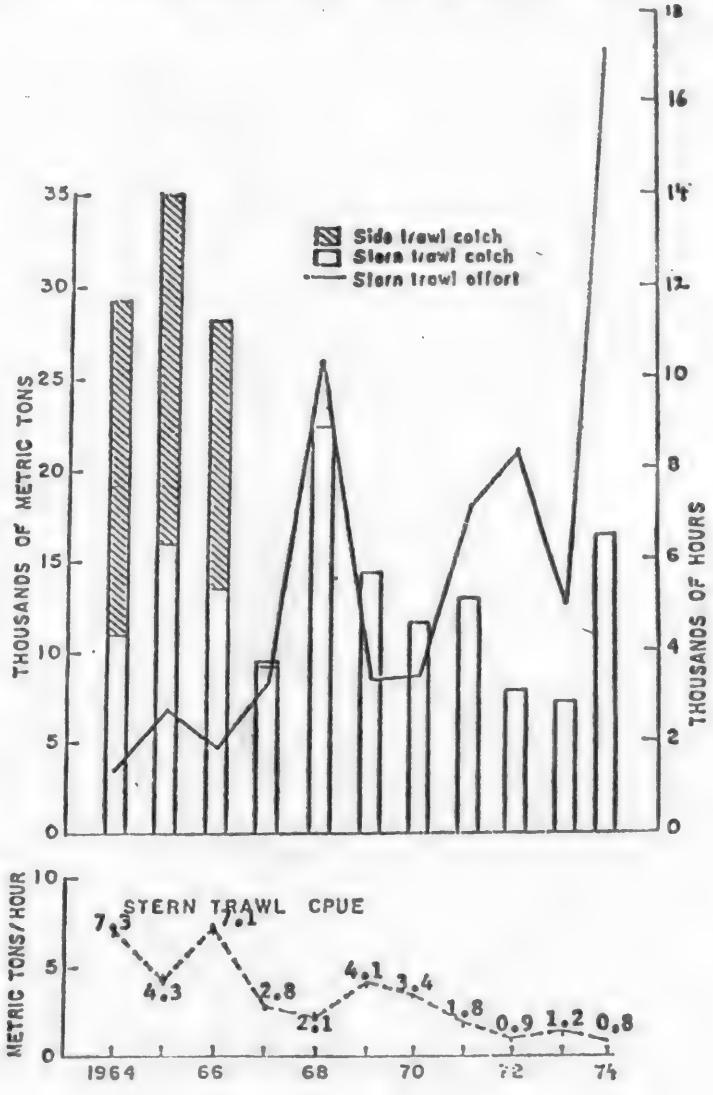


Figure 12.--Comparison of Pacific ocean perch catch, effort, and CPUE in the Aleutian Region by the Japanese mothership and North Pacific trawl fisheries, 1964-74.

In the early years of the fishery (1964–67), the size composition of the catch was relatively stable and dominated by fish greater than 28 cm (Figure 13). After that time, there were dramatic increases in the proportion of fish smaller than 28 cm, due to recruitment into the fishery of the strong year classes of 1961 and 1962 (Chikuni, 1974b) and in part to a considerable reduction in abundance of the larger-older perch after 1967. The abundance of these older fish remained low through 1974.

On the whole, catch rate and size composition information suggest that in the Aleutian Region both abundance and average size have been considerably reduced since the early years of the fishery. Stock condition appears to have been poorest in 1972 but seems to have been improving slightly since then. The optimistic trend of 1972–74 may not, however, continue because of the high catch of 22,400 mt in 1974.

(c) *Maximum sustainable yield:* As for other species in the Bering Sea which

have undergone considerable changes in population structure and abundance as a result of intensive "pulse" fishing, the interpretation of MSY must be viewed in its proper perspective. Under ideal resource conditions, MSY for the Pacific ocean perch stock in the Eastern Slope Region may be as high as 32 thousand mt; that in the Aleutian Region may be as high as 75 thousand mt (Chikuni, 1975a).

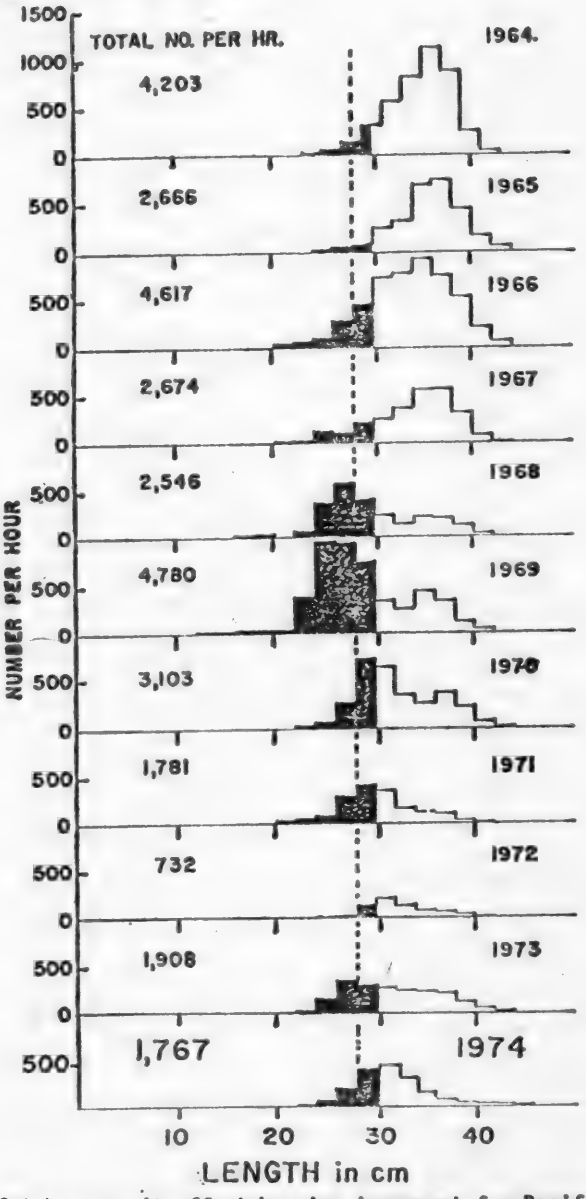


Figure 13.--Catch-per-unit-effort by size increment for Pacific ocean perch harvested by stern trawlers of the Japanese North Pacific Trawl fishery in the Aleutian Region, 1964-74.

(d) *Estimated equilibrium yield:* Since 1960, the Eastern Slope Region has produced catches in excess of 32 thousand mt only twice (1961 and 1968). Following high catches, CPUE and catch decreased substantially—for example, the 32 thousand mt catch in 1968 has been followed by catches of less than 15 thousand mt per year. Judging from catch patterns through 1974, the ocean perch stock in the Eastern Slope Region could not support removals of even 10–15 thousand mt annually without detrimental effects to the already low level of stock abundance.

In the Aleutian Region, there were clear cases of overexploitation in the early stages of the fishery when amounts in excess of 90 thousand mt were taken consecutively from 1964 through 1966 (Wolotira, 1975b). Since then, catches have dropped to 12 thousand mt in 1973 and 22 thousand mt in 1974. It is evident that the sustained annual catch of 75 thousand mt estimated by Chikuni cannot now be realized because of the poor condition of this stock.

Because ocean perch is a long-lived, slow-growing species with full maturity not occurring until age 9 and a life span of 25 years, stock conditions are not expected to improve for many years even if recruitment improves and removals remain at modest levels.

Low (1974) estimated equilibrium yield for both stocks combined, under stock conditions prevailing in the early 1970's, to be 12,000–17,000 mt. In view of the slight improvement noted in the Aleutian stock in very recent years, equilibrium yield might now be near 21,500 mt. Considering relative stock sizes and conditions, this yield might be reasonably apportioned as folows: 15,000 mt to the Aleutian stock; 6,500 mt to the Eastern Slope stock.

(5) *Sablefish.*—This species is covered thoroughly in a separate Preliminary Fishery Management Plan.

In general, sablefish stocks in the Bering Sea and Aleutian area are in poor condition, as evidenced by catch rates which have declined 24–93 percent since 1967 (Low, 1976).

Estimates of MSY, derived from a general production model, range from 10,000–20,000 mt, but slight overfishing for 15 years has caused a gradual decline in abundance, and the population in this region is now thought to be capable of producing an equilibrium yield of perhaps 8,000–10,000 mt.

(6) *Pacific Cod.*—a. *Distribution and abundance of stock:* Pacific cod are distributed widely over the Bering sea shelf but occur mainly on the continental slope. This distributional pattern is quite similar to that of pollock. During the early 1960's, when a fairly large Japanese longline fishery operated on the continental slope, cod was harvested by longliners for the frozen fish market. Beginning in 1964, the Japanese North Pacific trawl fishery for pollock expanded and cod became an incidental catch to the pollock fishery. At present, cod are believed to be only an occasional target species when high concentrations are detected during pollock fishing operations.

The annual catch of Pacific cod by Japan increased from 19,100 mt in 1964 to about 74,400 mt in 1970; since then, catches have varied between 41,000 and 50,600 mt. Catches by the USSR have been reported only since 1971 and have increased from 2,500 mt in 1971 to 16,600 mt in 1974. Therefore, for all nations combined, the Pacific cod catch for 1974 was the second highest on record at 67,200 mt.

The biology and behavior of Pacific cod in the Bering Sea have not been studied adequately to delineate stocks; catch patterns suggest that only a single stock exists in the eastern Bering Sea.

On the basis of catch history, the abundance of Pacific cod in the 1970's appears to be about 5 percent that of pollock. This estimate assumes that the catchability coefficients for pollock and cod are the same. However, it is more likely that this coefficient is lower for cod because of its pelagic and dispersed distribution.

(b) *Maximum sustainable yield.* Because of the lack of information concerning potential yield of cod in the Bering Sea and the difficulty of estimating its biomass, only a rough approximation of MSY is possible. Using Japanese commercial catch-effort statistics through 1973 and the surplus production model of Pella and Tomlinson (1969), Low (1974) estimated that the MSY for Pacific cod could be as high as 85,000 mt per year.

(c) *Status.* Pruter (1973) explained that the traditional catch-per-unit-effort measure of stock abundance is probably not a reliable estimator of Pacific cod abundance in the Bering Sea. Although catch rates for cod by gear type were computed by Takahashi (1975) and Low (1976) to indicate relative cod abundance, they are considered inadequate to gauge the current status of stocks. Japanese Danish seiners and pair trawlers account for most of the cod landings, but cod catch rates for these gear types—knowing that their effort is largely directed to target on walleye pollock—impart little information on the condition of stocks.

Size composition of cod landed by the Japanese fisheries generally varies from 30 to 80 cm (Figure 14). Because most of the cod were taken by trawl gear capable of retaining fish down to 20 cm and because there is no indication that selection for larger cod had taken place in the fishery, the proportion of small fish (below 40 cm) suggests that recruitment was low both in 1973 and 1974. This does not necessarily indicate that the stock is in poor condition, as year-to-year variations in recruitment are normal and expected. Since the stock (and fishery) is made up of fish varying over a wide size (and presumably wide age) range, a few years of poor recruitment should not be cause for concern.

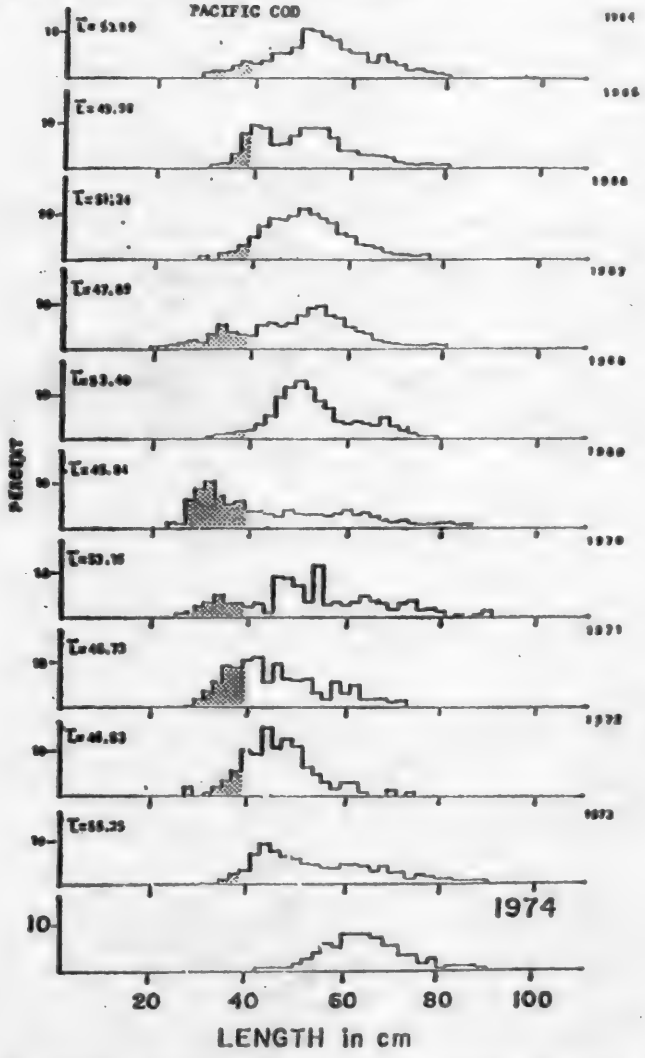


Figure 14.--Length frequency distributions of Pacific cod from samples of catches by the Japanese mothership, North Pacific trawl, and longline fisheries in the Bering Sea, 1964-74.

(d) *Equilibrium yield.* At present, there is no reason to believe that cod stocks in the Bering Sea are in poor condition; neither, however, is there evidence to show that higher catches would be sustainable. In fact, when the total catch exceeded 74,000 mt in 1970, catches subsequently declined. Therefore, equilibrium yield is considered to be equal to the 1962-74 catch level of about 58,000 mt.

(7) *Pacific Halibut.*—The demise of the North American setline fishery in the Bering Sea (and the halibut resource which supported it) has been well documented over the past 10 years (Table 16). Part of this deterioration may have been caused by combined North American and Japanese setline catches during 1960–63, but the situation was undoubtedly aggravated by the enormous incidental catch of juvenile halibut by Japanese and Soviet trawlers (International Pacific Halibut Commission, 1976; Hoag and French, 1974, 1975). Even though such incidentally caught halibut are to be returned to the sea by Japanese fishermen, most do not survive.

MSY as it applies to the setline fishery is believed by IPHC to be in the order of 2,000–3,000 mt.

In response to the critical halibut situation, arrangements were made through the International North Pacific Fisheries Commission and bilaterally with Japan and the U.S.S.R. for winter closures of key trawl grounds where juveniles were known to concentrate and were highly susceptible to trawls. These arrangements, instituted in late 1973, are still in force in slightly modified form.

Annual trawl surveys conducted by IPHC to estimate relative abundance of juvenile halibut showed that during 1966–72 catch per hour dropped from 31.8 to 3.1 individuals but increased in 1975 to 11.9. The recent increase is considered to be at least partially a result of the winter trawl closures. If such is the case, and similar protective measures continue, IPHC believes that enhancement of the North American setline fishery should become apparent by about 1980.

TABLE 16.—*Catch (metric tons, round weight) of Pacific halibut by North American and Japanese setlines in the Bering Sea.*

| Year | North American setline | Japanese setline | Total |
|---|---|---|---|
| 1958 | 1,313 | 1,271 | 2,584 |
| 1959 | 2,508 | 2,240 | 4,748 |
| 1960 | 3,408 | 6,931 | 10,339 |
| 1961 | 2,394 | [1] 11,141 | 13,535 |
| 1962 | 4,417 | [1] 9,898 | 14,315 |
| 1963 | 4,908 | [illegible] | 12,807 |
| 1964 | 1,405 | 709 | 2,114 |
| 1965 | 806 | 16 | 822 |
| 1966 | 721 | 215 | 936 |
| 1967 | 1,444 | 83 | 1,527 |
| 1968 | 797 | 168 | 965 |
| 1969 | 743 | 12 | 755 |
| 1970 | 685 | 5 | 690 |
| 1971 | 523 | 0 | 523 |
| 1972 | 442 | 0 | 442 |
| 1973 | 172 | 0 | 172 |
| 1974 | 264 | 0 | [illegible] |
| 1975 | 317 | 0 | 317 |

[1] Includes an unknown catch by trawls.

A winter trawl closure and a ban on retention of trawl-caught halibut are key elements of this plan—they are de-

signed to improve somewhat on the existing arrangements to hasten halibut stock rehabilitation and U.S. fishing potential.

(8) *Herring.*—There are three principal fisheries for Pacific herring in the eastern Bering Sea: a Japanese trawl fishery, a Soviet trawl fishery, and a Japanese gillnet fishery (Table 17). The Republic of Korea conducted a minor trawl fishery for herring off the Bering Sea coast of Alaska in 1974. The estimated catch by that fishery was 200 mt. The main trawl fisheries operated along and inside the 200-meter line between the Pribilof Islands and St. Matthew Island during the winter-spring months, November to March. The gillnet fishery operates off the Bering Sea coast of Alaska from Bristol Bay to Norton Sound during the spring months, usually April into June.

Herring is a species that shows strong schooling and migratory characteristics. Rumyantsev and Darda (1970) noted periodic large concentrations of herring which winter near Nunivak Island, Unimak Island, St. Matthew Island, and the Pribilofs, then move toward the Alaskan coast and into the Bays during summer.

Most concentrations large enough to sustain commercial fisheries are found in waters shallower than 200 meters. Their stock sizes vary considerably from year to year as year-class strength has a tendency to fluctuate widely. Because of this potential for annual variation in abundance (hence yield), MSY has little value.

TABLE 17.—*Catch of herring in metric tons, by Japanese and Soviet trawlers east of 180° in the Bering Sea and Japanese gillnet vessels west and east of 175° W. in the Bering Sea, excluding the Aleutian region, 1964–75.*

| Fishing year (July-June) | Trawl fisheries | | | Japanese gillnet fishery | | | |
|---|---|---|---|---|---|---|---|
| | Japan | U.S.S.R. | Total | Calendar year | West of 175° W. | East of 175° W. | Total |
| 1964–65 | 1,362 | (1) | (2) | 1964 | 41,597 | | 41,597 |
| 1965–66 | 3,117 | (1) | (2) | 1965 | 34,650 | | 34,650 |
| 1966–67 | 2,831 | (1) | (2) | 1966 | 24,118 | | 24,118 |
| 1967–68 | 9,486 | 9,800 | 19,286 | 1967 | 30,167 | | 30,167 |
| 1968–69 | 50,857 | 75,379 | 126,236 | 1968 | 5,183 | 818 | 6,001 |
| 1969–70 | 23,901 | 92,228 | 116,129 | 1969 | 680 | 1,949 | 2,629 |
| 1970–71 | 24,236 | 60,126 | 84,362 | 1970 | | 1,585 | 1,585 |
| 1971–72 | 13,143 | 67,547 | 80,690 | 1971 | | 4,603 | 4,603 |
| 1972–73 | 946 | 39,999 | 40,345 | 1972 | | 472 | 472 |
| 1973–74 | 219 | 16,810 | 17,029 | 1973 | | 1,878 | 1,878 |
| 1974–75 | 2,685 | 19,342 | 22,027 | 1974 | | 3,337 | 3,337 |
| | | | | 1975 [3] | | 651 | 651 |

[1] Not available. [2] Incomplete. [3] Preliminary.

DATA SOURCES: *Japanese fisheries:* International North Pacific Fisheries Commission docs. 833, 879, 1021, 1102, 1275, 1339, 1423, 1525, 1599, 1769, 1692, 1802, 1804, 1806 and 1813. *U.S.S.R. fishery:* 1967–75: Furnished by the U.S.S.R. under provisions of United States-U.S.S.R. fisheries agreements.

Analyses of catch and CPUE, uncorrected for the possible existence of more than one stock or for factors other than abundance (such as ice and weather) that might affect fishery performance, suggest a substantial decline in resource abundance: (1) A downward trend in total catch from the peak year of 1968–69 through 1974–75; (2) a general downward trend in CPUE of small Japanese trawlers; and (3) a recent sharp decline in CPUE of large Japanese trawlers (Mason, 1976).

These symptoms mirror those observed in the herring fishery of the western Bering Sea shortly before its collapse in the late 1960's.

Catches of 80,000–126,000 mt obviously could not be sustained, yet they were not so large as to obliterate the resource. Empirically, then, it can be reasoned that MSY is in the range of 50,000–100,000 mt, but that current equilibrium yield is much lower, perhaps near the 1974–75 catch level of 21,000 mt.

(9) *Squid.*—Although known from incidental research and commercial catches, and from stomach analyses of prey species to be abundant, little is known of the squid resource of the Bering Sea. Japanese records indicate a catch of 5,000 mt in 1975. Intuitively, MSY is greater than 10,000 mt.

(10) *Other Species.*—Little information concerning species composition, abundance, stock units, stock condition, or potential yield is available for the statistical category "other" included in the reported catches.

If the fishery seeks certain components and purposely avoids others, or if certain components are mixed with major target species and taken incidentally while others are not, exploitation rates would be grossly disproportionate among the components. This could easily lead to overfishing of certain species or localized stocks if the allowable catch for this category is a significant portion of the total catch for the entire fishery.

### 4.0 TOTAL ALLOWABLE LEVEL OF FOREIGN FISHING

#### A. OPTIMUM YIELD (PRELIMINARY DETERMINATION)

The concept of optimum yield incorporates consideration of a broad range of socio-economic factors relating to impacted fisheries, as well as the biological characteristics of the exploited stocks. In the time and with the data available, it has not been possible to make other than a cursory evaluation of socio-economic factors; hence for the purpose of this Preliminary (and interim) Management Plan, optimum yields are considered as equivalent to total allowable catches (TAC's). These figures have been determined on the basis of biological information concerning the characteristics of exploited resources, with certain adjustments to accommodate for the quality of the data base. Although regulations in this Preliminary Plan deal only with the activities of foreign vessels, the reduction in fishing levels implied by the TAC's in this Plan should result in improved stock conditions, and, therefore, improve the economic viability of the U.S. fisheries. Further adjustments of TAC's to attain optimality are anticipated in succeeding interations of the management plan.

#### B. TOTAL ALLOWABLE CATCH

Pertinent information concerning stock condition, sustainable yields under current conditions, domestic production potentials and the surplus available for foreign use is summarized in Table 18.

Rationales for differences, when they occur, between maximum sustainable yield (or equilibrium yield) and total allowable catch are as follows:

(1) *Walleye Pollock.*—Equilibrium yield for this resource is believed to currently be about one million mt. In order to begin restoring the population to the level of abundance that could produce MSY, a TAC of 850,000 mt would be appropriate. This, however, would result in a single step, one-third reduction in the foreign pollock catch. Anticipating little U.S. involvement in this fishery in the immediate future, and in a attempt to minimize the abruptness of economic dislocations in the foreign fisheries, the TAC in 1977 is set at 950,000 mt. This harvest level is not expected to permit significant rebuilding to occur, but it is believed to be low enough to arrest the downward trend in abundance.

(2) *Yellowfin Sole.*—Although the current estimate of exploitable biomass is based on seemingly firm survey data, and the exploitation rate used to estimate equilibrium yield is based on a generally recognized population model, the yellowfin sole resource is obviously not stable. Therefore, the TAC will be set conservatively at the low end of the equilibrium yield range—at 106,000 mt. This will allow a catch in 1977 that is more than 50 percent greater than the average of the last three years of record (1972–74).

TABLE 18.—*Total allowable level of foreign fishing in the Bering Sea and Aleutian Islands trawl fishery*

| Species | Data base | 1974 U.S. catch | 1974 foreign catch | Estimate MSY | Estimate EY | Status | 1977 TAC | U.S. capacity | Total allowable level of foreign fishing |
|---|---|---|---|---|---|---|---|---|---|
| Pollock | Good | 0 | 1,600,000 | 1,100,000–1,600,000 | 1,000,000 | Overfished from 1972–75; near-future recruitment looks poor; heavy reliance on juveniles. | 550,000 | 0 | 950,000. |
| Yellowfin sole | do | 0 | 31,000 | 70,000–270,000 | 106,000–147,000 | Greatly overexploited in early 1960's; signs of significant recovery in 1975–76. | 106,000 | 0 | 106,000. |
| Other flounders | Fair | 0 | 100,000 | 105,000 | 105,000 | Slightly underfished as a complex; some species or stocks may now be overexploited, others may have substantially more potential. | 105,000 | 0 | 105,000. |
| Pacific Ocean perch | Good | 0 | 65,000 | 110,000 | 21,500 | Greatly overexploited in early 1960's—remain depressed. | 6,500<br>15,000 | 0<br>0 | 6,500-areas I, II, III, combined<br>15,000-area IV. |
| Sablefish | Fair | 0 | 8,000 | 10,000–20,000 | 8,000–10,000 | Slight overfishing for 15 yr has caused gradual decline to current low level. | 5,000<br>2,400 | 0<br>0 | 5,000-areas I, II, III combined.[1]<br>2,400-area IV.[1] |
| Cod | do | 0 | 64,000 | 85,000 | 58,000 | Fully utilized; current recruitment appears lower than in recent past. | 58,000 | 0 | 58,000. |
| Halibut | Excellent. | 200 | 500 | 2,000–3,000 | (?) | Commercially extinct in terms of setline fishery due to high-incidental mortality of juveniles caused by trawling. | [2] Tr. | <Tr. | 0 to no retention. |
| Herring | Poor | Tr. | 30,000 | 50,000–100,000 | 21,000 | Overfished; probably subject to highly variable recruitment. | 21,000 | 1,000 | 20,000. |
| Squid | do | 0 | <5,000 | >10,000 | >10,000 | Known to be large resource | 10,000 | 0 | 10,000. |
| Others | do | 0 | 104,000 | (5) | (5) | (5) | 59,600<br>34,000 | 0<br>0 | 59,600-areas I, II, III combined.<br>34,000-area IV. |

[1] Applies to combined long-line and trawl catch
[2] Includes Canadaian catch.
[3] Limited North American setline fishery for resource assessment purposes.
[4] Tr.=Trace, less than 500 metric tons.
[5] Not applicable.

(3) *Other Flounders.*—The TAC for this species category in 1977 will be set at the level of current equilibrium yield—105,000 mt.

(4) *Pacific Ocean Perch.*—The TAC for this species in 1977 will be set at the equilibrium yield of 21,500 mt. Because stock condition and potential yield are quite different in the Bering Sea and the Aleutian areas, the TAC will be divided into 6,500 mt for the eastern Bering Sea proper and 15,000 mt from the Aleutian area.

(5) *Sablefish.*—Equilibrium yield for this resource is believed to currently be about 8,000 to 10,000 mt. In order to restore the population to the level which will eventually produce MSY, the TAC for 1977 will be set at 7,400 mt. Considering separately the condition of stocks in the eastern Bering Sea proper and along the Aleutian Island chain, the TAC will be subdivided into 2,400 mt from the Aleutian area and 5,000 mt from the Bering Sea proper.

(6) *Cod.*—At present, there is no reason to believe that cod stocks in the Bering Sea are in poor condition; neither, however, is there evidence to show that higher catches would be sustainable. In fact, when the total catch exceeded 74,000 mt in 1970, catches subsequently declined. Therefore, until further information concerning recruitment becomes available, total allowable catch will be held at the equilibrium yield level of 58,000 mt.

(7) *Halibut.*—The 1977 TAC for halibut will be controlled by measures adapted by the International North Pacific Fisheries Commission and the International Pacific Halibut Commission.

(8) *Herring.*—The TAC for this species in 1977 will be held near the catch set at the level of current equilibrium yield—21,000 mt.

(9) *Squid.*—A pre-emptive TAC of 10,000 mt will be set for 1977, with adjustments.

(10) *Other Species.*—The TAC for this species category in 1977 will be set 10 percent below the last catch of record—to 93,600 mt—with the intention of similar reduction in each succeeding year until it reaches no more than 2 percent of the total catch of the fishery. This phased reduction is intended to:

(a) Prevent circumventing individual species allocations by reporting significant overages in a large "Other" category;

(b) Prevent excessive exploitation of small or previously unfished stocks which are unregulated because of a lack of fishery or biological data; and

(c) Force more precise statistical reporting for resource assessment and management purposes.

## 5.0 CONSERVATION AND MANAGEMENT MEASURES APPLICABLE TO FOREIGN FISHERMEN

### A. REGULATIONS

The management policy for the Bering Sea shall be to arrest the decline in abundance of overfished stocks and allow them to begin rebuilding to levels that will produce MSY; to rebuild the halibut resource of the region to a level that will allow a viable U.S. setline fishery; and to prevent stocks that are currently healthy from being overfished.

All foreign vessels wishing to operate in this Management Unit must obtain a permit from the Secretary of Commerce.

(1) *Region-wide Restrictions.*—(a) No retention of salmon, halibut[6] or Continental Shelf Fishery Resources (to prevent covert on species of special importance to U.S. fishermen).[4]

b. No trawling or gillnetting within 12 miles of the baseline used to measure the Territorial Sea, except in the western Aleutian Islands as described in Appendix A (to prevent conflicts with U.S. fixed gear and small, inshore fishery vessels; to prevent catch of localized inshore species important to U.S. fishermen and natives).[4]

c. No fishing for shrimp (earlier foreign fisheries reduced this resource to commercial extinction).[4]

(2) *Time-Area Closures.*—(a) No trawling year-round in the Bristol Bay "Pot Sanctuary," i.e. in the area enclosed by straight lines from Cape Sarichef to 55°16′ N–166° W, to 56°20′ N–163°00′ W, to 58°10′ N–166°00′ W, then due south along 160°00′ W to the Alaska Peninsula (to prevent conflicts between foreign mobil gear and concentrations of U.S. crab pots).[4]

b. No trawling from December 1 to May 31 in the following INPFC Conservation Areas (Figure 15) (to protect winter concentrations of juvenile halibut, to protect spawning concentrations of pollock and flounders).[4]

No trawling from December 1 to May 31 in the following INPFC Conservation Areas (Figure 15) (to protect winter concentrations of juvenile halibut, to protect spawning concentrations of pollock and flounders).[5]

1. Area B.
2. Area E, east of 166° W—south of 56° N.
3. Area E, west of 166° W—south of 56°30′ N.
4. Area A, south of 55°30′ N.
5. Misty Moon Ground.

c. No fishing for herring year-round east of 168° W, north of 58° N (to prevent overexploitation of specific herring stocks important to the well-being of native Eskimo fishermen and villages).[5]

d. This management unit (or individual sub-areas where specific quotas apply) will be closed to fishermen of a nation for the remainder of the calendar year when that nation's allocation of any species listed in Table 18 is exceeded (to discourage foreign fleets from covertly targetting on depleted species/stocks and to prevent damaging by-catches after the allotted catch has been taken; this provision places the burden of responsibility on the foreign fleets to avoid taking such species/stocks and to develop fishing gear and fishing practices which will minimize or eliminate their incidental capture.

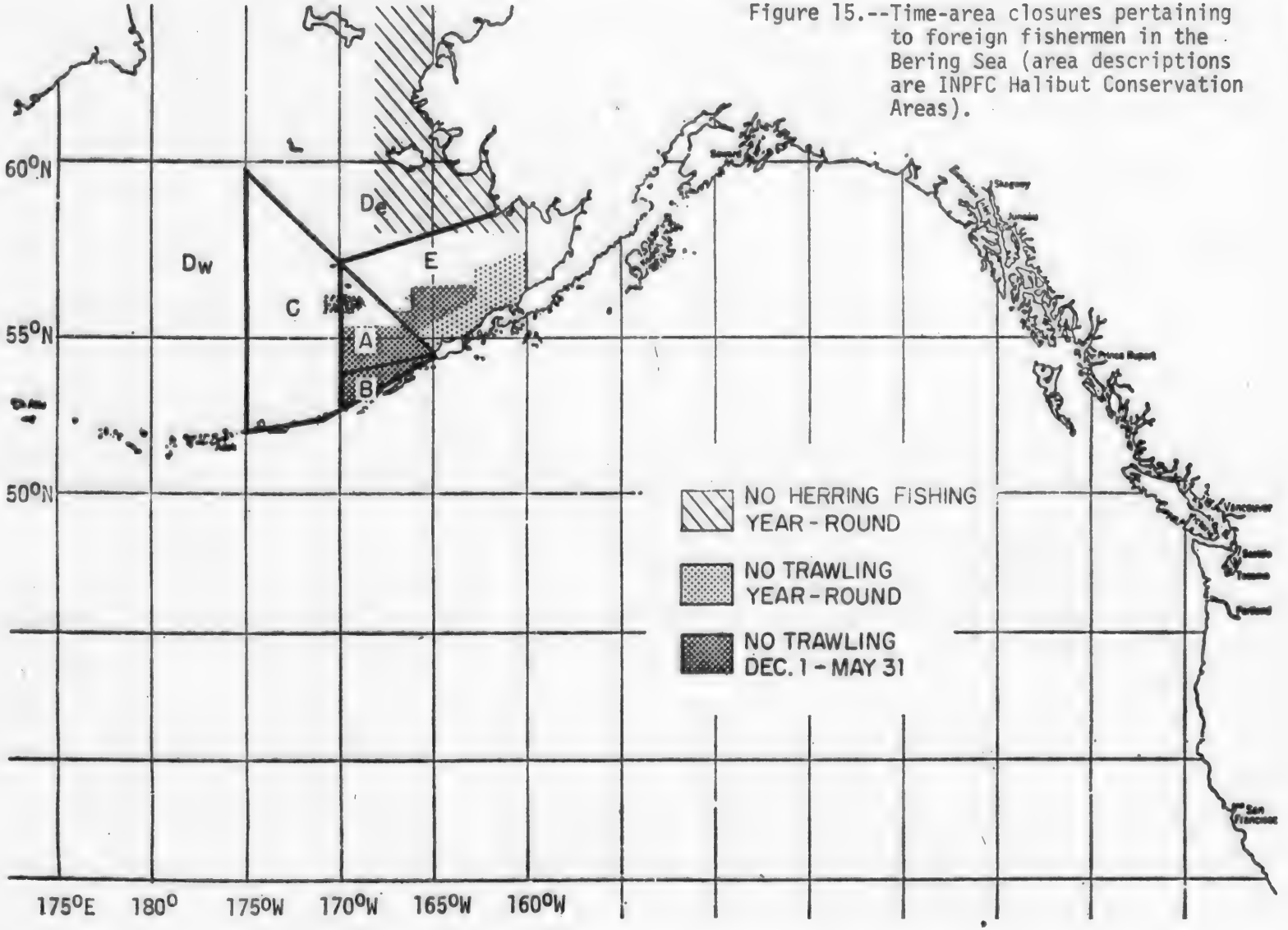


Figure 15.--Time-area closures pertaining to foreign fishermen in the Bering Sea (area descriptions are INPFC Halibut Conservation Areas).

B. STATISTICAL REPORTS

(1) *Annual.*—Each nation whose fishermen operate in the Region shall report[7] by May 30 of the following year—annual catch and effort statistics, as follows: Effort in hours trawled, by vessel class, by gear type, by month, by ½° (lat.) ×1° (long.) statistical area; Catch in metric tons, by vessel class, by gear type, by month, by ½° (lat.) ×1° (long.) statistical area, by the following species groupings:

Yellowfin sole, rock sole, flathead sole, arrowtooth flounder, Greenland turbot, other flounders, Pacific ocean perch, Pacific cod, sablefish (backcod), walleye (Alaska) pollock, Atka mackerel, Pacific herring, squid, any other species taken in excess of 1,000 mt, other fishes.

(2) *Monthly.*—In addition to the annual statistical report in (1) above, each nation will report[7] by the end of the following month, provisional fishery information for each month as follows: Effort in vessel-days on the grounds by vessel-class and gear-type; and Catch in metric tons of flounders, rockfishes, cod, pollock, sablefish, Atka mackerel, herring, squid, and others, for each of the areas shown in Figure 16.

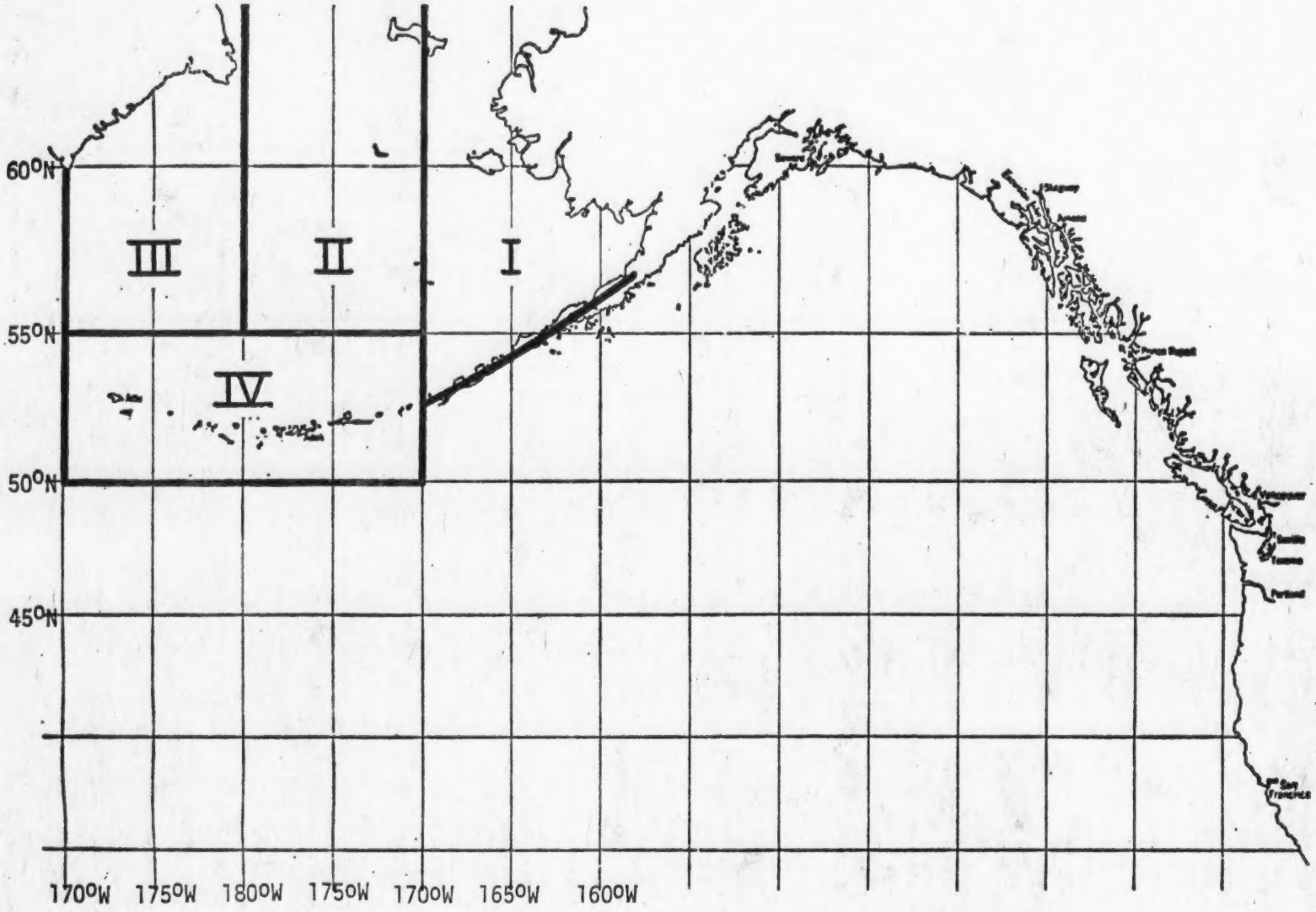


Figure 16.--Major statistical areas in the Bering Sea.

C. FLEET DISPOSITION REPORTS

The appropriate fleet commander or individual vessel master will report[7] by radio prior to the commencement of fishing, the arrival in this management unit of each fishing and processing vessel, giving the vessel's name and other identifying marks, size, and intended target species. A similar report[7] will be made at the time of departure of each vessel from the Region. These reports, augmented with U.S. surveillance observations and monthly catch and effort reports, will be used to monitor adherence to limitations.

D. OBSERVERS

All vessels of each nation operating in this management unit will have available at no cost to the U.S., accommodation for one U.S. observer. Observers will be assigned to individual vessels and for periods at the discretion of the U.S. to measure daily catch rates; estimate species, size, and age composition; collect other biological data as appropriate; determine location and duration of hauls; and observer gear dimensions and performance.

E. RESEARCH

Bona fide fishery or fishery-related research (but not exploratory fishing) by foreign governments will be encouraged. Valid results of such research will be considered by the management entity in determining total allowable catches and other management measures. Cooperative U.S.-foreign research ventures will be planned and executed when they are found to be in the best regional interest of the U.S.

## 6.0 Relation to National Standards

The prescriptive measures contained in this Preliminary Fishery Management Plan (total allowable catches, allocation to foreign fishermen, and regulations pertaining to foreign fishermen) have been designed to be consistent with the seven national standards listed in Pub. L. 94–265.

Total allowable catches are entirely for the purpose of preventing overfishing (standard No. 1), are based upon the best scientific evidence available (standard No. 2), and are applied to the extent possible to individual stocks or stock complexes throughout their range (standard No. 3).

Inasmuch as this document deals solely with foreign fisheries, that provision of the legislation concerning nondiscrimination among the residents of states (standard No. 4) does not apply.

Those regulations which isolate the foreign trawl fisheries from fisheries for other species (2.4.1.2.a) and from key areas where there are incidental catches of species especially important to the U.S. (2.4.1.2.b) will promote efficiency in resource utilization (standard No. 5) by reducing potentials for gear conflict, incidental catch of non-target species, and exploitation of juvenile fish which have not reached the size where cohort production is maximized. Further, the provision (2.4.1.2.c) which calls for termination of a nation's fishing operations in the region when the quota for any species is achieved will promote efficiency in resource utilization by providing a tremendous incentive for developing species-specific gear and fishing strategy.

Monthly catch reports (2.4.2.2), check-in/check-out procedures (2.4.3), and observers monitoring fishery performance (2.4.4) will permit the timely detection of anomolies in the catch or the fishery (standard No. 6).

Reliance upon easily monitored time-area closures (2.4.1.–2) will minimize that surveillance and enforcement activity required to assure foreign compliance to this plan (standard No. 7).

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## 8.0 FOOTNOTES

[1] M=0.26; a=0.45 (0.5 used by Alverson & Pereyra, 0.4 used by Gulland); $B_o$=1.3-2.0 million mt.

[2] From Chikuni (1975a) fecundity, in thousands of eggs, by age are 10 at age 7, 29 at age 10, 75 at age 15, 122 at age 20, and 162 at age 25.

[3] Except Canadian fishermen under provisions of the Halibut Convention of 1953.

[4] Identical to current bilateral arrangements.

[5] Similar to current bilateral arrangements but somewhat more restrictive.

[6] New restriction.

[7] To the Director, Alaska Region, Natl. Mar. Fish. Serv., Juneau, Alaska.

## 9.0 APPENDICES

### APPENDIX A

I. Areas in the Aleutian Islands where foreign fishing is permitted up to the Territorial Sea.

(A) In the waters off the Bering Sea coast of the Aleutian Islands:

(1) Between 169° and 170° West longitude, dragnet fishing from May 16 to November 30 inclusive, and longline fishing year-round;

(2) Between 170° and 172° West Longitude, dragnet and longline fishing year-round;

(3) Between 172° and 176° West Longitude, longline fishing from April 1 to October 31 inclusive;

(4) West of 176° West Longitude, dragnet fishing from May 1 to December 31 inclusive and longline fishing year-round.

(B) In the waters off the Pacific coast of the Aleutian Islands:

(1) Between 169° and 172° West Longitude, dragnet and longline fishing and loading year-round;

(2) Between 172° and 178°30′ West Longitude, longline fishing from April 1 to October 31 inclusive;

(3) Between 176° and 178°30′ West Longitude, dragnet fishing from July 1 to October 31 inclusive;

(4) west of 178°30′ West Longitude, dragnet fishing from May 1 to December 31 inclusive and longline fishing year-round.

II. Misty Moon Ground.

That area bounded by straight lines connecting the following coordinates in the order listed:

| *North latitude* | *West longitude* |
|---|---|
| 56°18′ | 170°24′ |
| 56°20′ | 169°03′ |
| 56°12′ | 168°46′ |
| 55°56′ | 169°10′ |
| 55°56′ | 170°24′ |

### APPENDIX B—SUMMARY

CONDITIONS AND RESTRICTIONS

Subpart F—Bering Sea and Aleutian Islands Trawl Fishery

*1.0 Definitions*

(a) Unless otherwise defined herein, the terms used in this Subpart will have the meanings ascribed to them.

(b) The conditions and restrictions shall apply to all species of fish and invertebrates taken in trawl gear,

(c) The regulatory area for taking those species listed in (b) above is defined to include that portion seaward of the Territorial sea in the Bering Sea and Aleutian Islands over which the United States exercised fisheries jurisdiction.

*2.0 Catch quotas*

(a) The 1977 annual catch quotas for foreign fishermen in the Bering Sea and Aleutian Islands are as follows:

| *Species* | *Catch quota (metric tons and area)* |
|---|---|
| Pollock | 950,000. |
| Yellowfin sole | 105,000. |
| Other flounders | 100,000. |
| Pacific Ocean perch. | 6,500, East Bering Sea; 15,000, Aleutians. |
| Sablefish | 5,000, East Bering Sea; 2,400, Aleutians. |
| Cod | 57,000. |
| Herring | 20,000. |
| Others | 59,600, East Bering Sea; 34,000, Aleutians. |

*3.0 Open season*

(a) The open season for foreign fishing in the Bering Sea and Aleutian Islands area will be consistent with the time-area closures in section 4.0.

(b) The open seasons for foreign fishing in the Aleutian Islands area within 12 miles of and beyond 3 miles from the baseline used to measure the territorial sea are as follows:

(1) In the waters off the Bering Sea coast of the Aleutian Islands;

1. Between 169° and 170° West longitude, dragnet fishing from May 16 to November 30 inclusive, and longline fishing year-round.

2. Between 170° and 172° West longitude, dragnet and longline fishing year-round.

3. Between 172° and 176° West longitude, longline fishing from April 1 to October 31 inclusive.

4. West of 176° West longitude, dragnet fishing from May 1 to December 31 inclusive and longline fishing year-round.

(2) In the waters off the Pacific coast of the Aleutian Islands:

1. Between 169° and 172° West longitude, dragnet and longline fishing and loading year-round.

2. Between 172° and 178°30′ West longitude, longline fishing from April 1 to October 31 inclusive.

3. Between 176° and 178°30′ West longitude, dragnet fishing from July 1 to October 31 inclusive.

4. West of 178°30′ West longitude, dragnet fishing year-round.

*4.0 Closed seasons and areas*

Trawling by foreign vessels is prohibited in the following areas:

(a) No trawling year round in the Bristol Bay "Pot Sanctuary", i.e. in the area enclosed by straight lines from Cape Sarichef to 55°16′N—166°10′W, to 56°20′N—163°00′W, to 57°10′N—163°00′W, to 58°10′N—166°00′W, then due south along 160°00′W to the Alaska Peninsula.

(b) No trawling from December 1 to May 31 in the following INPFC Conservation Areas:

1. Area B.
2. Area E east of 166°—south of 56°30′N.
3. Area E west of 166°W—south of 56°N.
4. Area A—south of 56°N.

(c) The entire region will be closed to fishermen of a nation when that nation's allocation of any species listed in Section 2.0 is exceeded.

*5.0 Gear restrictions*

Gear restrictions for foreign fishing in the regulatory area are described in Section 3.0 during the open season for specific areas.

*6.0 Statistical reporting*

(a) Annual. Each nation whose fishermen operate in the Region shall report by May 30 of the following year—annual catch and effort statistics, as follows: *Effort* in hours trawled, by vessel class, by gear type, by month, by ½° (lat.) x 1° (long.) statistical area; *Catch* in metric tons, by vessel class, by gear type, by month, by ½° (lat.) x 1° (long.) statistical area, by the following species groupings:

Yellowfin sole
Rock sole
Flathead sole
Arrowtooth flounder
Greenland turbot
Other flounders
Pacific ocean perch
Pacific cod
Sablefish (blackcod)
Walleye (Alaska) pollock
Atka mackerel
Pacific herring

Any other species taken in excess of 1,000 mt
Other fishes

(b) Monthly. In addition to the annual statistical report in (a) above, each nation will report by the end of the following month, provisional fishery information for each month as follows:

"Effort" in vessel-days on the grounds, by vessel-class, and gear-type; and "Catch" in metric tons of flounders, rock-fishes, cod, pollock, sablefish, Atka mackerel, herring, and others.

*7.0 General restrictions*

(a) No retention of salmon, halibut, or CSFR.

(b) No trawling within 12 miles of the baseline used to measure the Territorial Sea, except in the Western Aleutian Islands as described in Section 3.0 above.

(c) No fishing for shrimp.

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